DIGITAL COUNTERS

TYPES TSA 6634A/2 & 2M
TSA 6636/2 & 2M

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INSTRUCTION MANUAL

VENNER ELECTRONICS LIMITED
KINGSTON BY-PASS NEW MALDEN SURREY
TELEPHONE 01-942 2442
A MEMBER OF THE VENNER GROUP OF COMPANIES

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Telephone : 01-942 2442

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PREFACE

This instruction manual deals with two types of digital counter, the 4-digit counter type TSA6634A/2 and the 6-digit counter type TSA6636/2 which is capable of higher frequency measurement than the former instrument.

The main text of the manual is applicable to both instruments. Where differences exist in the design or operation of the two counters they are treated separately; such sections are clearly marked.

An optional extra which (if initially ordered) may be incorporated in either type of counter, is the facility for storage of a measurement while another is accumulated. For counters carrying this facility the suffix-letter 'M' is added to the instrument type number. Outputs for data-logging equipment may also be provided as an optional facility but only in conjunction with the storage facility; presence of the data outputs is denoted by type-number-suffix 'Z' engraved on the rear panel label. Appropriate text dealing with the two facilities is clearly indicated in this manual.

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Signal-Flow / Function Chart	-	S65/22
Double Decade Type 66/100	BL66/100	ES66/29
Decade Divider Type 66/140	BL66/140	ES66/36
Power Supply Type 66/210	BL66/210	E66/98
Pulse Shaper Type 66/301	BL66/301	E 68/9
Oscillator Type 66/512	BL66/512	ES66/24
Gate Control and Reset Type 66/602	BL66/602	ES66/77
Low Speed Counter Type 66/710	BL66/710	ES66/91
Low Speed Counter and Store Type 66/710M	BL66/710M	ES66/89
High Speed Counter Type 66/720	BL66/720	ES66/92
High Speed Counter and Store Type 66/730	BL66/730	ES66/90

DIGITAL COUNTERS

TYPES: TSA6634A/2 and TSA6636/2

INTRODUCTION

Each instrument is a versatile counter for the measurement of Frequency and Frequency-ratio, Period measurement (by single period or multi-period sampling), Timing and for general purpose Counting.

The readout is presented by side-view neon indicator tubes which are mounted behind a display screen for optimum contrast.

The accuracy of all time-dependent measurements is determined by the reference source which is an oven-controlled 2 MHz high stability crystal oscillator. A 2 MHz Test frequency output and a Standard Frequency output (selectable in decade steps from 0.1 Hz to 1 MHz) are obtainable at front-panel-mounted sockets. Sensitivity and display time controls are incorporated and provision is made for the gating circuit to be controlled by external signals and for the use of an external reference source.

Display Storage facility and Data Logging Outputs are two optional features which are provided only if initially ordered.

Silicon semi-conductor devices are used throughout the circuit which consists essentially of plug-in printed circuit boards. The outer housing of the unit comprises a ventilated p.v.c. covered dual-sectioned wrap; this may be easily removed to give access to the interior of the instrument. A swivelling carrying handle of aluminium alloy is fitted and may be locked in position to form a tilt stand.

2 SPECIFICATION

2.1 Power Supply

100-125 V, 40-60 Hz or 400Hz; or

200-250 V, 40-60 Hz or 400Hz

(For voltage adjustment see Section 3.1)

	TSA6634A/2	TSA6636/2
Consumption:	approx. 26 W	approx. 35 W

2.2 Frequency Measurement

	TSA6634A/2	TSA6636/2
Frequency Ranges:	A.C.: 10Hz to 10MHz	10 Hz to 12.5 MHz
	D.C.:D.C. to 10MHz	D.C. to 12.5 MHz
Accuracy:	± 1 count ± crystal stability	
	Crystal frequency: 2 MHz	
	Crystal stability: ± 1 part in 10^6	

Signal Specification:	TSA6634A/2	TSA6636/2
A.C.: Min. amplitude	75 mV r.m.s.	75 mV r.m.s. (10 Hz to 10 MHz)
		100 mV r.m.s. (10 MHz to 12.5 MHz)
Max. amplitude	250 V r.m.s.	250 V r.m.s.
D.C.:	Max. amplitude ± 250V peak	
	Trigger level + 1 V max.	

Pulse Response: A.C./D.C.

The instrument is triggered by positive-going signals of amplitude greater than 125mV.

Paired pulse resolution: 0.2 μs (i.e. with pulse width 0.1 μs and pulse spacing 0.1 μs)

Input Impedance (Min.): A.C.: 250 kΩ shunted by 40 pF

D.C.: For frequencies above 10 Hz:- as for A.C.
Input resistance to D.C. approx. 100 kΩ

Gating Times (selectable): 1 μs to 10 sec. in decade steps

Count Capacity:	TSA6634A/2	TSA6636/2
	9999	999999

2.3 Period Measurement

Range: 10 Hz to 1 MHz

Accuracy: As for Frequency measurement ± Trigger level error

Trigger level error:-

With input signals of low frequency and near-minimum amplitude (75 mV) the error on the ranges is:-

Range	:	Error
1	:	± 0.3%
10	:	± 0.03%
10^2	:	± 0.003%

The error is reduced by a factor of ten for each subsequent range.

The accuracy on each range improves rapidly with increase in signal amplitude above 1 V r.m.s.

Signal Specification: As for Frequency measurement

Input Impedance: " " " "

Count Capacity: " " " "

Gating Times (selectable on Multi-period): 1 to 10^7 cycles (in decade steps) of input frequency

Time Unit: On 'Multi-period' :- 1 μs

On 'Timing A-A'(single period):- 1 μs to 10 sec selectable in decade steps

2.4 Timing

	TSA6634A/2	TSA6636/2
Range:	1 μs to 99990 seconds (approx. 27.7 hrs.)	1 μs to 9999990 seconds (approx. 111 days)

Count Capacity: As for Frequency measurement

Accuracy: ± 1 μs $^{+0}_{-1}$ time unit

Time Units: 1 μs to 10 sec in decade steps

For gate control Start and Stop signals see Section 2.6

2.5 Count

Count Capacity: As for Frequency measurement

Frequency Range: " " " "

Signal Specification: " " " "

Input Impedance: " " " "

For gate control Start and Stop signals see Section 2.6

2.6 Start and Stop Inputs

(For external gate control on functions 'Timing B-C' and 'Count')

Signal: Negative-going

Amplitude (Min.) -4 V; Max. Rise Time 0.5 μs

" (Max.) -50 V; " " " 5 μs

Input Impedance: (each line)

Up to -6 V:- approx. 50 kΩ in parallel with 150 pF

Above -6 V:- " 100 kΩ " " " 5,000 pF

Alternative control by momentary contact closure of appropriate (Start and Stop) input socket to chassis-earth, or by momentary depression of appropriate (Start or Stop) push-button.

2.7 External Reference Input

Frequency:	100 Hz to 1.5 MHz (Refer to Section 3.9)
Signal Amplitude:	0.5 V to 50 V r.m.s.
Input Impedance:	50 kΩ in parallel with 100 pF

2.8 Test Frequency Output

Frequency:	As selected Reference Frequency (2 MHz when Internal Reference is selected)
Signal Amplitude:	Approx. 4 V peak to peak
Waveform:	Sinusoidal
Output Impedance:	1 kΩ

2.9 Standard Frequency Output

Frequency:
(Determined by setting of Range switch when Function Selector is set to FREQUENCY*)

(i) With Internal Reference selected:-

1 MHz to 0.1 Hz selectable in decade steps

(ii) With External Reference selected:-

External reference frequency divided by 1 to 10^7 selectable in decade steps

N.B. Frequencies as in (i) above when External Reference is 1 MHz

Signal Amplitude:	Approx. 5 V peak to peak
Waveform:	Rectangular
Output Impedance:	Approx. 5 kΩ

2.10 Data Logging Output

(Applicable only to counters bearing type-number-suffix 'Z' on rear panel label)

4-lines per digit, plus 1 control line

Code: 1-2-4-8 b.c.d.

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* For signals produced at this output when Function Selector setting is other than FREQUENCY, see Section 3.8

Digit Lines:	'1' : More positive than + 3.5 V '0' : Between 0 V and +0.5 V (Open-circuit d.c. levels with respect to chassis-earth) Output Impedance approx. 1 kΩ
Print Command Signal	5 V negative-going pulse: Rise-time approx. : 200 ns Pulse width approx. : 40 μs Output Impedance: Not greater than 1 kΩ

2.11 Display

Display time adjustable between approx. 0.5 and 5 seconds: on 'Infinity' setting display retained until reset push-button is depressed.

Display Storage facility (applicable only to counters bearing type-number-suffix M)

Display switch set to:-

'Normal':	Storage facility unused; display time as above
'Stored':	Readout retained until end of new sampling period

2.12 Temperature Range

-10 deg. to +55 deg. Centigrade

2.13 Weight and Dimensions

Weight (approx.)	Case dimensions (approx.) :-		
	Width	Height	Depth (front to rear)
$12\frac{1}{2}$ lb.	10-3/8 in.	5-1/8 in.	12-1/8 in.
(5.7 kg.)	(26.4 cm.)	(13 cm.)	(30.8 cm.)

3. OPERATING INSTRUCTIONS

3.1 Mains-Voltage Setting

The mains transformer of the internal power unit has twin primary windings which may be series-connected for operation on supply voltages in the range 200 to 250 V a.c., or parallel-connected for operation on supplies in the range 100 to 125 V a.c.

The instrument is normally despatched set for 200 to 250 V a.c. operation.

To select the other voltage-range first remove both sections of the case. To remove a section, withdraw the 4 BA fixing screw from either side, slide cover backwards sufficiently to disengage front-edge from panel surround, then lift away.

The plug-in power unit is situated adjacent to the rear panel: withdraw its three fixing screws (arranged in triangular formation around the cut-out on the underside of the chassis), disengage the flying-plug and remove the unit from the instrument.

The primary windings are terminated on that side of the transformer where the tags are arranged viz:-

Note: X represents tag

X 120 V - live input-line

X 0 V

X 120 V

X 0 V - neutral input-line
(base of power unit)

The 'live' and 'neutral' lines should remain connected as indicated above.

For 100 to 125 V a.c. connect windings in parallel (i.e. link* 120 V tags together and link* O V tags together).

For 200 to 250 V a.c. connect windings in series (i.e. link* together the two inner tags).

Replace and secure the power unit, re-connect the flying-plug and secure the instrument case before connecting the supply.

3.2 Supply Connection

With mains transformer appropriately connected (see Section 3.1) and with Sensitivity control set to its anti-clockwise limit (the mains switch mechanically coupled to this control will then be OFF) connect 3-core mains cable to supply as follows.

---

* By means of a soldered wire

Brown (or Red) core : mains live
Blue (or Black) core : mains neutral
Green & Yellow (or Green) core : earth

Slight clockwise rotation of the Sensitivity control will switch ON the supply within the unit.

3.3 Test Facility

Note: Although measurements may be taken immediately after the supply has been switched ON, in order that the degree of accuracy achieved shall conform to the specification a period of at least 15 minutes should be allowed to elapse for temperature stabilization of the internal crystal oven. The oven is operative on all functions, but no warm-up period is necessary if the function to be used is Count, for then the output of the crystal oscillator is unused and results are independent of oscillator frequency.

To check the counting and readout operations of the instrument set rear-mounted Crystal Reference switch to 'INT', feed output of Test socket (2 MHz) to coaxial A-Input socket (centre-pin) and set Sensitivity control to 'MAX'.

Instruments which possess the display storage facility carry a two-position switch marked Display; to enable the progress of the count to be observed this switch should be set to 'Normal'.

Below are listed for each setting of the 8-position Range switch displays which should be presented for the 'Frequency', 'Multi-period' and 'Timing A-A' positions of the Function Selector.

N.B. Display Time switch may be set either to 'INF' (each new count is then initiated upon momentary depression of Reset push-button*) or to 'AUTO', for which measurements will occur automatically* (duration of display being dependent upon setting of Display Timer).

TSA6634A/2 Displays:-

Range Switch Setting	Function Selector Setting		
	Frequency	Multi-period	Timing A-A
1	0002 ±1	0001 ±1	0001 ±1
10	002.0 ±1	0005 ±1	00.00 ±1
10^2	02.00 ±1	0050 ±1	000.0 ±1
10^3	2.000 ±1	0500 ±1	0000 ±1

* Except on functions 'Timing B-C' and 'Count' for which measurements are initiated by a START signal (at input B).

10^4	000.0 ±1	5000 ±1	00.00 ±1
10^5	00.00 ±1	0000 ±1	000.0 ±1
10^6	0.000 ±1	0000 ±1	0000 ±1
10^7	000.0 ±1	0000 ±1	0000 ±1

N.B. Results for the '10^7' setting are presented after a 10 second gating time.

TSA6636/2 Displays:-

Range Switch Setting	Function Selector Setting		
	Frequency	Multi-period	Timing A-A
1	000002 ±1	000001 ±1	000001 ±1
10	00002.0 ±1	000005 ±1	0000.00 ±1
10^2	0002.00 ±1	000050 ±1	00000.0 ±1
10^3	002.000 ±1	000500 ±1	000000 ±1
10^4	02000.0 ±1	005000 ±1	0000.00 ±1
10^5	2000.00 ±1	050000 ±1	00000.0 ±1
10^6	000.000 ±1	500000 ±1	000000 ±1
10^7	00000.0 ±1	000000 ±1	000000 ±1

N.B. Results for the '10^7' setting are presented after a 10 second gating time.

Operation for the Function Selector setting 'Timing B-C' is perhaps most easily checked with the Range switch set to 10^4. Momentarily depress the Reset push-button. Upon a momentary depression of the Start push-button the instrument should commence to count; the display being presented in 'Seconds' (with the decimal point centrally positioned). The second most significant digit should increase at one count per second until timing is stopped by momentary depression of the Stop push-button.

All internal gating, counting and readout circuits will have been checked during the above operations; the following procedure will therefore suffice to check the Function Selector circuit for the setting 'Count A/B-C'. Set the Function Selector to 'Count A/B-C', then momentarily depress the Reset push-button. Upon momentary depression of the Start push-button, cycles of the 2 MHz Test frequency (applied at input A) will be counted and therefore give rise to a rapid change in display which will cause all digits of each display tube to be illuminated simultaneously. However, upon momentary depression of the Stop push-button a distinct display should be presented.

3.4 Frequency Measurement

3.4.1 Principle of Operation

In this function the setting of the 8-position Range switch determines which of eight

internal signal frequencies, derived from the reference oscillator, shall control the gate: it thus determines the gating time.

During this time, cycles of the A-input frequency pass via the gate and are counted by a chain of decade/indicator-drive stages. The indicators present the resultant count: where appropriate a decimal point is included in the display so that the result is in MHz, kHz or Hz as indicated by the setting of the Range switch.

3.4.2 Measurement Procedure

(Refer to 'Note' in Section 3.3)

(i) Set rear-mounted Crystal Reference switch to 'INT' (If an external reference source is to be used, refer to Section 3.9).

(ii) If data logging output facility (on units thus fitted) is to be used, refer to Section 3.10.

(iii) Set Display Time switch to either:-

1. 'INFinity': for this setting the Reset push-button must be momentarily depressed for a measurement to be initiated, or
2. 'AUTOmatic': for this setting measurements are initiated automatically; duration of each readout is determined by setting of Display Timer (min. setting approx. 0.3 second; max. setting approx. 5 seconds).

For an instrument carrying the display storage facility, set Display switch as required.

'Normal': For each measurement the indicators show the progression and result of each count.

'Stored'*: Only the result of the count is displayed; it is retained until the end of the next gating period whereupon the new count is shown.

Note: On 'Stored' setting no visible change will occur in the display should the new count be the same as the previous result.
When overflow occurs on 'Normal' setting the extreme left hand indicator can be seen to reset from 9 to 0, whereas on 'Stored' setting no such evidence of overflow is available since only the final result held by the counters is made visible. It is therefore advisable to determine the magnitude of a measurement on 'Normal' setting before using the 'Stored' setting.

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* On this setting, depression of the Reset push-button resets the counter circuit but the display remains unchanged.

(iv) Turn Sensitivity control initially to 'MAX'.

Note: This setting is suitable for smooth-edged waveforms of amplitude 75 mV to 250 V r.m.s. When interference is present or leading and/or trailing waveform-edges are irregular (e.g. due to harmonic content) reduce sensitivity should it be found, by a few initial measurements, that the instrument is triggered more than once in a cycle; the latter is manifested by excessive counts. In general a sensitivity setting consistent with input amplitude is desirable: the control is most effective at low input frequencies owing to its low pass filter action.

(v) Select A.C. or D.C. input coupling by use of A.C./D.C. switch and connect input signal lead to coaxial socket 'A' (Centre-pin: 'high' signal line. Shell: chassis-earth).

(vi) Set Function Selector to 'FREQUENCY' (marked in black on the panel). The corresponding black scale of the Range switch is applicable to displays on this function: set the switch to a range suitable for measurement of the input frequency. When the order of frequency is unknown, use highest range (1 μs gating time) first.

The gating times for the switch positions (clockwise order) are as follows.

Range switch position		Gating Time
1	(MHz)	1 μs
2	"	10 "
3	"	100 "
4	"	1 ms
5	(kHz)	10 "
6	"	100 "
7	"	1 second
8	(Hz)	10 seconds

(vii) Momentarily depress the Reset push-button for a measurement to be initiated. (On 'AUTO' setting, measurements will henceforth occur automatically).

The number displayed (which includes a decimal point for all Range switch settings except '1') is the frequency of the input signals in MHz, kHz or Hz as indicated by the setting of the Range switch.

Note. Whether the count capacity of the instrument is exceeded during a measurement depends upon the input frequency and the range employed. The most significant digit indicator resets from 9 to 0 whenever the count capacity is exceeded.

Example of Measurement:-

For TSA6634A/2:

A frequency of 100023.4 Hz measured over a gating time of 10 ms* would produce the display 100.0** (kHz). The same frequency measured over a gating time of 10 seconds would cause the count capacity to be exceeded one hundred times during the measurement and would produce the display 023.4**. The first to third most significant digits (M.S.D.), i.e. 100, would therefore not be shown: the figure presented by the right hand indicator would then be the 7th M.S.D.

Thus, in general once the first few M.S.D.s of a measurement have been determined, the frequency may be resolved to a greater accuracy by use of lower ranges.

For TSA6636/2:

A frequency of 100023.4 Hz measured over a gating time of 10 ms* would produce the display 00100.0** (KHz). The same frequency measured over a gating time of 10 seconds would cause the count capacity to be exceeded once during the measurement and would produce the display 00023.4**. The most significant digit (M.S.D.), i.e. 1, would therefore not be shown: the figure presented by the right hand indicator would be the 7th M.S.D.

Thus, in general once the first few M.S.D.s of a measurement have been determined, the frequency may be resolved to a greater accuracy by use of lower ranges.

3.5 Multi-period Measurement

Note. On this function single-period measurement is catered for by position '1' of the Range switch (the count is recorded in 1 μs units): single period measurements may also be taken on function 'Time A-A' where the time unit is selectable: refer to Section 3.6.2.

3.5.1 Principle of Operation

In this function, signals applied at input-A control the gate which is held open for 'n' periods of the input waveform, where 'n' is the setting (e.g. 10^2) of the Range switch. During the gating time, pulses derived from the reference oscillator and which occur at a rate of 1 per microsecond pass through the gate to the counter/display circuit. The result is a measurement of the time (in microseconds) for which the gate is held open and is a period or multi-period measurement (depending upon the Range switch setting) of the

---

* Gating times are listed in procedure (vi) above

** The display is subject to the accuracy stated in Section 2.2

input waveform.

3.5.2 Measurement Procedure

(Refer to 'Note' in Section 3.3)

Carry out procedures (i) to (v), inclusive, of Section 3.4.2; then proceed as follows.

Set Function Selector to 'MULTI-PERIOD' marked in blue on the panel. The correspondingly coloured scale of the Range switch is applicable to this function: set the switch to the number of periods over which the measurement is to be made (1 to 10^7 periods in decade steps are selectable). The range selected should be chosen to suit the order of the input frequency so that the count capacity will not be exceeded. Once the first few digits of a measurement have been determined, other ranges (over which the count capacity may be exceeded) can be used for the determination of lesser significant digits: therefore, in general the lowest range '1' should be used first, then higher ranges progressively.

Momentarily depress the Reset push-button for a measurement to be initiated. (On 'AUTO' setting, measurements will henceforth occur automatically).

The count is registered in microsecond units.

Example of Measurement:-

For TSA6634A/2:

Consider a frequency in the order of 100 kHz, whose period is 10.2345* μs, measured first on range '1': the resultant display would be 0010(μs). If range '10^4' were then used the count capacity would be exceeded ten times during the measurement and the resultant display would be 2345*(μs): since this is produced over 10^4 periods of the input waveform the count should be divided by 10^4 to obtain the value 0.2345 μs for one period. Appending the first two digits '10' (determined on the first range) gives 10.2345 μs as the period of the input signal.

For TSA6636/2:

Consider a frequency in the order of 100 kHz whose period is 10.234567*μs measured first on range '1': the resultant display would be 000010(μs). If range 10^6 were then used the count capacity would be exceeded ten times during the measurement and the resultant display would be 234567*μs: since this is produced over 10^6 periods of the input waveform the count should be divided by 10^6 to obtain the value 0.234567 μs for one period. Appending the first two digits '10' (determined on the first range) gives 10.234567 μs as the period of the input signal.

Trigger Level Error

Results are subject to trigger level error which is manifested in repeated measure-

---

* The display is subject to the accuracy stated in Section 2.2

ments by jitter of the least significant digit/s. The error is more pronounced with input signals of low frequency and near minimum amplitude (75 mV): for such signals the error is:-

Range	:	Error
1	:	± 0.3%
10	:	± 0.03%
100	:	± 0.003%

The error is reduced by a factor of ten for each subsequent range.

The accuracy on each range improves rapidly with increase in signal amplitude above 1V r.m.s.

3.6 Timing

3.6.1 Principle of Operation

For Timing, two functions are provided. On 'Timing A-A' the gate is opened by the first pulse received at the A-input and is closed by the second. During the gating time pulses derived from the reference oscillator pass through the gate at a rate of 1 per microsecond and thence pass via a frequency divider chain to the counter/display circuit. The Range switch determines the division factor of the frequency divider chain and therefore the unit of time in which the result is displayed.

On 'Timing B-C' the gate is opened and closed by signals applied at the B and C input sockets respectively, or by depression of the START and STOP push-buttons. The function of the timing signal circuit, however, is as described for the previous case.

3.6.2 Timing A-A Measurement Procedure

(Refer to 'Note' in Section 3.3)

Carry out procedures (1) to (v), inclusive, of Section 3.4.2, then proceed as follows.

(a) Set Function Selector to 'TIMING A-A' (marked in red on the panel).

(b) The red scale of the Range switch is applicable to displays on this function. Set the switch for time unit in which the interval is to be measured; time units of 1 μs to 10 seconds are available in decade steps from the first switch-position (μs) to last switch-position (sx10) respectively.

(c) Connect the input signal lead to coaxial socket A.

(d) Momentarily depress the Reset push button.
(For Display Time switch setting 'AUTO', further operation of this push-button is not required in taking successive measurements, since reset action prior to each new measurement is triggered automatically.)

Note: Where appropriate a decimal point is included in the resultant display so that, providing the count capacity is not exceeded, the complete time measurement is displayed in the units of time (μs, ms or seconds) indicated by the setting of the Range switch.

3.6.3 Timing B-C Measurement Procedure

(i) Carry out procedures (i) to (iii), inclusive, of Section 3.4.2.

(ii) Set Function Selector to 'TIMING B-C' (marked in red on the panel).

(iii) Carry out procedure (b) of Section 3.6.2 above.

(iv) To start the gating time apply a Start signal* to the coaxial socket marked 'B' or momentarily depress the START push-button.
To end the gating time apply a Stop signal * to the coaxial socket marked 'C' or momentarily depress the STOP push-button.
Alternatively, should single line gate control be required the Start and Stop inputs may be linked together (i.e. centre pins of sockets B and C linked together).
In such a case two successive signals presented (after occurrence of reset action) between the link and chassis-earth will cause the gate to open and close respectively.

Note: External leads to inputs B and C should be screened and kept as short as practicable to minimise pick-up which might otherwise cause unwanted trigger operation.
It is recommended that, where practicable, circuits used to trigger the B and C inputs be battery powered in order to eliminate the possibility of the instrument being triggered by spurious mains-initiated pulses or ripple.

(v) The Note appearing at the end of Section 3.6.2 is applicable also to this function.

3.7 Count

3.7.1 Principle of Operation

In this function the gate is opened and closed by signals applied at the B and C input sockets respectively, or by depression of the START and STOP push-buttons.

During the gating time, signals received at input-A pass via the gate to the counter/display circuit.

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* For signal specification see Section 2.6

3.7.2 Measurement Procedure

Carry out procedures (i) to (v), inclusive, of Section 3.4.2; then proceed as follows.

(a) Set Function Selector to 'COUNT A/B-C'

(b) Momentarily depress the Reset push-button

(c) To start and stop the gating operation see Section 3.6.3 (iv)

Providing the count capacity is not exceeded, the resultant display shows the total number of A-input signals received during the gating time.

3.8 Standard Frequency Output

When the Function Selector is set to 'FREQUENCY' signals* derived from the internal reference oscillator (or from an external 1 MHz reference source, when such is employed) are available at the front-panel-mounted socket marked 'STD. FREQ'S': the signal frequency is dependent upon the setting of the Range switch as indicated below. (Note: The signals are momentarily interrupted whenever reset action is initiated).

Range switch positions (clockwise order)	Standard Frequency Output
1	1 MHz
2	100 kHz
3	10 "
4	1 "
5	100 Hz
6	10 "
7	1 "
8	0.1 "

Note: Since the 'STD. FREQ'S' socket is fed by the output of the internal frequency divider, signals are also produced at this socket for other settings of the Function Selector but they are then dependent upon the gating operations and/or the signal input frequency. On MULTI-PERIOD the divider is fed by A-input signals (received via an internal pulse shaper); on both TIMING functions it is fed, only during the gating period, by the oscillator output frequency (normally 1 MHz**). For these functions the signal frequency at the output socket is:-

$$\frac{\text{The divider input frequency}}{\text{Range switch setting (blue figures)}}$$

On COUNT function the divider is unused; therefore no output signals are provided at the 'STD. FREQ'S' socket.

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* For signal specification see Section 2.9

** i.e. when INT reference is selected or when 1 MHz EXT reference is used.

3.9 External Reference Facility

When the rear-mounted Crystal Reference switch is set to 'INT' the internal 2 MHz oscillator is employed as reference source and signals from the oscillator are then present at the coaxial socket marked 'EXT.' (Note: When the latter setting is used, no external signals should be applied at the 'EXT.' socket, otherwise the instrument will not function correctly due to multiple trigger operation by the two timing signal sources.)

When the switch is set to 'EXT', the internal oscillator is switched out of circuit and signals applied to the Crystal Reference socket* serve as reference signals for the instrument.

This facility may be used to increase the accuracy of the instrument for the standard functions (i.e. by use of a 1 MHz source frequency whose accuracy is superior to that of the internal crystal: see Section 2.2) or to alter the significance of the readout so that the instrument will operate in a non-standard manner (i.e. by use of an external source frequency other than 1 MHz)

The facility may be used for frequency ratio measurement; the subject is treated in the following section.

3.9.1 Frequency Ratio Measurement

Frequency ratio measurement of signals from two sources may be conducted when the Crystal Reference switch is set to 'EXT'. Signals from one source should be applied to the Crystal Reference socket*; those from the second source should be applied to the A-input socket.

The measurements may be conducted with the Function Selector set to FREQUENCY or MULTI-PERIOD, the two functions will be treated separately.

Note: Procedures (ii), (iii), (iv) and (v) of Section 3.4.2, which relate to the use of Display Time and A-input controls and to data logging facilities, are applicable in the following functions.

(a) Frequency Function

With the Function Selector set to FREQUENCY, signals (of frequency f_1) applied to the EXT Crystal Reference socket pass via a frequency divider chain to the internal gate control circuit; the gate is held open while a number of pulses, equal to the division factor of the chain, is received at the 'EXT' input socket. The division factor is indicated by the setting of the Range switch (blue scale) and is selectable in decade steps from 1 to 10^7.

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* For signal specification see Section 2.7

During the gating period, signals (of frequency f_2) applied to signal input A pass via the gate to the counter.

The Displayed Count = $\frac{f2}{f1}$ x division factor

Example:

With f1 = 80 kHz ; f2 = 20 kHz ; Function Selector set to FREQUENCY and Range switch set to 10^4 the displayed count would be 2500.

Therefore

$$2500 = \frac{f2}{f1} \times 10^4$$

The ratio f1 : f2 is therefore given by:-

$$\frac{\text{Division factor}}{\text{Count}} : 1$$

i.e. $\frac{10^4}{2500} : 1$

or $4 : 1$

(b) Period Function

With the Function Selector set to MULTI-PERIOD, signals (of frequency f1) applied to the EXT Crystal Reference socket pass via the gate to the counter during the gating time.

The gate is controlled by signals (of frequency f2) applied at input socket A. The signals pass via a frequency divider chain to the internal gate control circuit: the gate is held open while a number of pulses, equal to the division factor of the chain, is received at input A. The division factor is indicated by the setting of the Range switch (i.e. 1 to 10^7 in decade steps).

The Displayed Count = $\frac{f1}{f2}$ x division factor

Example

With f1 = 80 kHz; f2 = 20 kHz ; Function Selector set to MULTI-PERIOD, Range switch set to 10^3 the displayed count would be 4000.

Therefore

$$4000 = \frac{f1}{f2} \times 10^3$$

The ratio f1 : f2 is therefore given by:-

$$\frac{\text{Count}}{\text{Division Factor}} : 1$$

i.e. $\frac{4000}{10^3} : 1$

or $4 : 1$

Note: When using either function ('a' or 'b' above) the Range switch-setting used should be such that the capacity of the counter is not exceeded. In general, maximum accuracy is achieved when displayed count is the greatest obtainable without exceeding the count capacity.

3.10 Data Logging Output Facility

This facility is an optional extra and is provided only if initially ordered; however, it can be provided only in conjunction with the display storage facility. For instruments carrying data logging output the suffix Z is added to the instrument type number engraved on the rear panel label: the output is provided at a 36-pin Amphenol socket mounted adjacent to the Crystal Reference switch on the rear panel.

For each digit, information is presented in b.c.d. 1-2-4-8 form.

Pin Connections

Pin connections at the 36-pin Amphenol socket are as follows.

Note: M.S.D. = Most significant digit
L.S.D. = Least significant digit

TSA6634A/2:-

Pin No.	Function	Pin No.	Function	Pin No.	Function
1	MSD Line 1	13	3rd MSD Line 4	25	Unused
2	MSD Line 2	14	3rd MSD Line 8	26	Unused
3	MSD Line 4	15	Unused	27	Unused
4	MSD Line 8	16	LSD Line 1	28	Unused
5	Unused	17	LSD Line 2	29	Unused
6	2nd MSD Line 1	18	LSD Line 4	30	Unused
7	2nd MSD Line 2	19	LSD Line 8	31	Unused
8	2nd MSD Line 4	20	Unused	32	Unused
9	2nd MSD Line 8	21	Unused	33	Print Command O/P*
10	Unused	22	Unused	34	Chassis-earth
11	3rd MSD Line 1	23	Unused	35	Unused
12	3rd MSD Line 2	24	Unused	36	Unused

* From terminal point D of board type 66/730

TSA6636/2:-

Pin No.:	Function	Pin No.:	Function	Pin No.	Function
1 :	MSD Line 1	13 :	3rd MSD Line 4	25:	Unused
2 :	MSD Line 2	14 :	3rd MSD Line 8	26:	LSD Line 1
3 :	MSD Line 4	15 :	Unused	27:	LSD Line 2
4 :	MSD Line 8	16 :	4th MSD Line 1	28:	LSD Line 4
5 :	Unused	17 :	4th MSD Line 2	29:	LSD Line 8
6 :	2nd MSD Line 1	18 :	4th MSD Line 4	30:	Unused
7 :	2nd MSD Line 2	19 :	4th MSD Line 8	31:	Unused
8 :	2nd MSD Line 4	20 :	Unused	32:	Unused
9 :	2nd MSD Line 8	21 :	5th MSD Line 1	33:	Print Command O/P*
10 :	Unused	22 :	5th MSD Line 2	34:	Chassis-earth
11 :	3rd MSD Line 1	23 :	5th MSD Line 4	35:	Unused
12 :	3rd MSD Line 2	24 :	5th MSD Line 8	36:	Unused

For signal specification refer to Section 2.10

Note: The data logging outputs are provided by the count-storage circuits; therefore, on 'Stored' setting the recording time of logging equipment may extend up to the end of the subsequent gating period. On 'Normal' setting, to ensure that data logging shall be completed before the instrument is reset, the recording time must not exceed the minimum display time of the instrument.

* From terminal point D of board type 66/730

4. MAINTENACE

4.1 Case Removal

CAUTION: Whenever the instrument is operated with the case removed, care should be exercised to ensure that no physical contact is made with exposed connections, particularly those of the mains circuit in the regions of the Sensitivity control and power unit.

Each section of the case is secured by one 4BA screw at each side. To remove a section withdraw both fixing screws, slide the cover backwards sufficiently to disengage the front-edge from the panel surround, then lift away.

4.2 Fuses and Adjustment of Preset D.C. Supplies

The counter employs a power unit type 66/210 situated near the rear of the instrument. The power unit provides three d.c. supplies: ± 6V stabilised supplies for the transistor circuits and a +235V anode-supply for the neon indicator tubes and decimal point lamps.

The three d.c. supplies are present at the power unit inter-connecting socket, but since mains connections exist at pins 7 & 8, and since the connector is not readily accessible, it is reccommended that to check the voltage, the supplies be measured at the chassis mounted connectors of the plug-in boards.

Below are listed the power unit socket connections (for circuit reference only) with their corresponding voltages, lead colours, and equivalent points for voltmeter connection.

Power Unit Inter-connector	Supply Line	Lead Colour	Voltmeter Connection	
			Board Connector	Connector Pin **
Pin No:				
9	OV	Black	1st from L.H. side *+	3rd pin from rear (or chassis-earth)
1	+6V	Red	" " "	2nd pin from rear
2	-6V	Mauve	" " "	1st pin from rear
3	+235V	Yellow	2nd " "	last pin from rear

Should access to the power unit fuses and preset voltage controls be required during the following procedure, remove the top section of the case: then remove the power unit cover-plate (secured by three crosshead screws) to reveal the fuses and controls which are mounted on the printed circuit board of the power unit thus:-

FS1 FS2 FS3 RV2 RV1

(fuses) (-6V +6V)
(voltage controls)

To check and adjust the ±6V supplies proceed as follows:-

i) ±6V. Connect the negative-lead of a suitable voltmeter* to the 0V supply line (see connection table above) and the positive lead to the +6V supply line. The meter should indicate 6V: if necessary adjust RV1 for this value.

Note: In absence of supply, switch OFF mains and check mains input fuse (500 mA Venner Part No. Z22867/2)at rear of instrument, if the latter is in order, check power unit fuses FS2 and FS3 (1. 5A Venner Part No. Z26413/2).

* Suitable voltmeter 'AVO' Model 8 set to 10 V d.c. range.
*+ L.H.S. = Left hand side of chassis (i.e. Reset push-button side)
** The pins are coated with inspection paint, therefore ensure that good contact is made by voltmeter probes.

ii) -6 V. Remove voltmeter and re-connect thus:

Positive lead to 0V line, Negative lead to -6V line. The meter should indicate 6V; if necessary adjust RV2 for this value.

Note: In absence of supply, switch OFF mains and check power unit fuses FS2 and FS3 (1.5 A Venner Part No. Z26413/2).

iii) The functions of RV1 and RV2 are to some extent inter-dependent, therefore, should their settings have been altered, repeat procedures (i) and (ii) above until the required voltages are obtained without adjustment of the controls.

Disconnect the voltmeter.

To check the +235 V supply, connect a suitable voltmeter* thus: Negative lead to 0V line, Positive lead to +235V line. The supply should be 235 V ± 10% on-load (or approx. 270 V ± 10% off-load). No control is provided for this supply since stabilization is not required.

Note: In absence of supply, switch OFF mains and check power unit fuse FS1 (100 mA Venner Part No. Z26413/1).

4.3. Adjustment of Preset Oscillator-Trimmer

An oscillator trimmer-capacitor is mounted on the base-plate of the instrument behind the Crystal Reference switch and adjacent to the crystal oven. The control is preset and in normal circumstances no adjustment should be necessary.

The oscillator frequency (2 MHz) may be monitored at the front-panel-mounted TEST socket when the Crystal Reference switch is set to 'INT': the monitored frequency should be compared with an appropriate external standard frequency and the trimmer adjusted if necessary.

Note: Adjustment of the trimmer should not be made until the instrument has been operated for a period of at least 10 minutes (i.e. when sufficient time has elapsed for temperature stabilization of the Crystal oven).

4.4 Digital Indicator and Printed Circuit-Board Replacement

The neon indicator tubes are wired to printed circuit plug-in counter/display boards; it is recommended that in the event of failure of an indicator, or of a fault having been traced to a plug-in circuit board, the board concerned be removed and returned to Venner Electronics Limited for rectification.

A finger-grip/spacer is fitted at the top of each plug-in printed circuit board; their colours signify board types. Guides for the boards are fitted to the mechanical structure of the instrument and are correspondingly coloured as that for board re-

* Suitable voltmeter 'AVO' Model 8 set to 250 V d.c. range.

insertion appropriate positions are readily discernible.

Note: For stage complement see Section 5.1; for stage layout see diagrams S66/46 and S66/47.

4.5 Decimal Point Lamp Replacement

Note: The decimal point lamps should be illuminated in turn when (with the Function Selector set to FREQUENCY) the Range switch is set to 10^2, 10^3 and 10^4 consecutively.

Should a decimal point neon lamp fail to function, note the position of the faulty lamp, switch OFF and disconnect the supply; then proceed as follows.

(i) Remove the top half of the case: see Section 4.1

(ii) Remove the knobs of the Function Selector and Range switch: each is secured by two grub screws.

(iii) Remove the four fixing screws of the front panel assembly (these are 'Pozidriv' screws situated, one near each corner of the front panel).

(iv) Lift away the front panel (this will expose a sub-panel).

(v) Allow the sub-panel, with surround, to swing forward about its lower edge: to permit this, the capacitor mounted behind the Sensitivity control may be withdrawn from its retaining clip.

(vi) The decimal point lamp containers (small black hollow rod-like containers) are mounted behind the display screen. At the base of each container two soldering pins serve as terminating points for the leads to, and wires of, the decimal point lamp. Disconnect the wires of the faulty lamp; then fit and connect replacement lamp:- Venner Part No. Z50398.

(vii) Replace the capacitor referred to in (v) above and re-assemble the instrument.

4.6 Maintenance of Plug-in Pulse Shaper Board Type 66/301

A resistor (R2*) of selected value and preset potentiometers (RV1 & RV2*) are incorporated in this stage. In normal circumstances no maintenance in respect of these components should be necessary; however, replacement of R2 and potentiometer adjustment are treated in circuit description sheet 'CD.66/301' provided near the rear of this manual.

4.7 Colour Coding of Leads

On the main circuit diagrams ES67/20 and ES67/21 certain wires bear encircled reference letters and/or numbers (e.g. those on wires from the rotors of switches SA7 and SF2). Within the instrument such leads are correspondingly colour coded so that they

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* On drawing E68/9

may be readily identified and traced through cable-forms.

The colour code system employed is as follows.

Single-coloured Leads:

An encircled letter on the diagram represents a lead of one colour viz:-

A = Red B = Violet D = Black

When two or more leads of a particular colour are used they are numbered by means of a coloured sleeve at each end: sleeve colours used, conform to the standard colour code for resistors. Thus the encircled diagram-reference A1 represents a red lead with a brown sleeve.

Bi-coloured Leads:

An encircled reference consisting only of digits represents a bi-coloured lead. Again the standard resistor colour code is used to represent the digits.

Where both digits of a lead-number are identical (e.g. 11, 22 etc.) and are therefore represented by the same colour, the bi-colour system is maintained by the inclusion of the colour Pink: therefore an orange/pink lead corresponds to the number 33.

On each lead, the colour with the lower numerical significance should be read first (e.g. a blue/red lead should be read as 26, not as 62). However, the order of reading should be reversed if a Pink sleeve is carried at the end of the lead.

5. CIRCUIT DESCRIPTION

5.1 Circuit Diagrams and Plug-in Board Complement

The main circuit of the instrument is shown on:-

Diagram ES67/20 for counters types TSA6634A/2 and TSA6636/2

Diagram ES67/21 for counters types TSA6634A/2M and TSA6636/2M

On the diagram each plug-in stage (i.e. printed circuit board or power unit) is represented as a block containing the stage type number and the bracketed drawing number of the relevant circuit diagram.

The stage complement is as follows.

(Note: Colour-code refers to colour of finger-grip/spacers: see Section 4, 4)

			TSA6634A		TSA6636	
Type	Title	Colour-code	/2	/2M*	/2	/2M*
66/100	Double Decade	Grey	3	3	3	3
66/140	Decade Divider	Black	1	1	1	1
66/210	Power Supply	-	1	1	1	1
66/301	Pulse Shaper	Red	1	1	1	1
66/512	Oscillator	Green	1	1	1	1
66/602	Gate, Control and Reset	Beige	1	1	1	1
66/710	Low Speed Counter	Light Blue	3	-	5	-
66/710M	Low Speed Counter with Store	Light Blue	-	3	-	5
66/720	High Speed Counter	Dark Blue	1	-	1	-
66/730	High Speed Counter with Store	Dark Blue	-	1	-	1

The arrangement of stages in counters types TSA6634A/2 and TSA6636/2 are shown in layout diagrams S66/46 and S66/47 respectively.

5.2 General Circuit Description

This section treats the general operation of the counter and relates to the main circuit diagram of the instrument. Circuit descriptions for the individual stages follow Section 5.2.8.

Note: For the significance of lead-references which appear on the main diagram, refer to Section 4.7.

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* Or /2MZ

5.2.1 Mains and Internal Supplies

The mains supply is received at the 3-core cable (for core colours refer to Section 3.2) and is applied via interference suppressors L1 and L2, double-pole switch SG* and fuse FS1 (0.5 A) to the plug-in power supply (pins 7 and 8).

The power unit provides three d.c. supplies:- A +235 V anode-supply (at pin 3) for the indicator tubes and decimal point lamps (V1-3), and ±6 V H.T. supplies at pin 1 and pin 2 respectively (voltage levels are with respect to pin 9 i.e. the OV line or chassis-earth). A 12.6 V a.c. output provided between pin 5 and pin 6 serves to power the thermostatically controlled oven which houses the crystal of the internal reference oscillator.

5.2.2 Input (A) Signal Circuit

Signals received at coaxial signal input socket SKTA pass to the Sensitivity control RV1 either via capacitor C1 (i.e. when input coupling selector SC is set to position 1 'AC') or directly (i.e. when SC is set to position 2 'DC'). Signals from RV1 are applied to pulse shaper type 66/301. For this stage C2 serves as decoupling capacitor for the -6 V line at TP1**: an 'inhibit signal' line is connected at TP5***

Positive output pulses at TP6 of the shaper are available at wafer-1 of function selector SA and are used as gate input signals on functions Frequency and Count. Negative output pulses at TP8 are available at function selector wafers 3 and 4 where they are selected to control the gate on function Timing A-A: the pulses are also available at wafer-5 where, for function Multi-period, they are selected to feed a frequency divider chain and wafer-1 stator-1 of the range switch SB.

5.2.3 Reference Signal Circuit

Oscillator type 66/512 employs temperature controlled crystal XL1 and preset trimmer C6. With no 'inhibit signal' present at input TP12 of the stage*** and with Crystal Reference switch SF set to position-2 (INTernal) the 2 MHz output, at TP8 of the oscillator, is passed via C7 and wafer SF1 to TP10 (shaper input) and test socket SKTC: for this switch condition the -6 V supply is applied by wafer SF2 to TP14 so that the frequency divider of the oscillator stage operates to provide 1 MHz output signals at TP16.

With switch SF set to position-1 (EXTernal), signals from an external 1 MHz reference source applied at socket SKTD feed the shaper input (TP10) and Test socket

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* Switch SG is ganged to Sensitivity control RV1

** TP = Termination point

*** The 'inhibit signal' is treated in Circuit Description Sheet CD66/602 near the rear of this manual.

SKTC; the +6 V supply is applied by SF2 to TP14 so that frequency division does not occur within the oscillator stage and hence (providing the 'inhibit signal' is not present at TP12) 1 MHz output signals are produced at TP16. Since for this switch setting the internal oscillator is not required, its output is earthed by SF1 rotor to prevent inter action between the two signal sources.

The 1 MHz output signals at TP16 are available at function selector wafer SA1 where, for Multi-period function and both Timing functions, they are selected for use as gate input signals; the 1 MHz output is also available at wafer SA5 where it is selected on Frequency function to feed the frequency divider chain and wafer-1 stator-1 of range switch SB.

5.2.4 Frequency Divider Chain and Standard Frequency Output

This chain comprises Decade Divider type 66/140 and three Double Decades type 66/100: it is fed by signals selected by function selector wafer SA5 (i.e. 1 MHz oscillator output signals on Frequency function; the negative output pulses of the input shaper on Period function and gated signals from TP13 of the gating stage 66/602 on both Timing functions): the chain is not used for Count function.

Outputs of the decades are available at range-switch wafer SB1 viz:-

Stator 1 : Frequency as at SA5 rotor	(1 MHz on Frequency function*)
Stator 2 : Frequency as at SA5 rotor $\div 10$	(100 kHz on Frequency function*)
Stator 3 : Frequency as at SA5 rotor $\div 10^2$	(10 kHz on Frequency function*)
Stator 4 : Frequency as at SA5 rotor $\div 10^3$	(1 kHz on Frequency function*)
Stator 5 : Frequency as at SA5 rotor $\div 10^4$	(100 Hz on Frequency function*)
Stator 6 : Frequency as at SA5 rotor $\div 10^5$	(10 Hz on Frequency function*)
Stator 7 : Frequency as at SA5 rotor $\div 10^6$	(1 Hz on Frequency function*)
Stator 8 : Frequency as at SA5 rotor $\div 10^7$	(0.1 Hz on Frequency function*)

Signals selected by SB1 rotor are available at function selector wafers SA3 and SA4 for use as gate control signals on functions Frequency and Multi-period: at wafer SA2 they are available for use on Timing functions to feed the counter/display circuit; they are also fed via R3-C5 to the standard frequency output socket SKTB.

5.2.5 Gate and Control Circuits

Stage type 66/602 houses the gate and main control circuits. With the instrument in the reset state, the first negative pulse to occur at SA3 rotor opens the gate, whilst the next negative pulse to occur at SA4 rotor closes it. The sources of these pulses for positions 1 to 3 of the above wafers have been described earlier: for positions 4 and 5,

* i.e. When Internal Reference is used, or when 1 MHz External Reference is used.

however, the pulses are produced upon momentary depression of push-buttons Start (SD) and Stop (SE) respectively, or upon application of suitable signals at Start input (SKTE) and Stop input (SKTF) respectively*. For these inputs MR1-4 serve as clamping diodes for input signals of excessive amplitude.

Signals selected by function selector rotor SA1 feed the input of the gate, TP14. (The sources of these signals have been previously described). Gated signals produced at TP13 are available at function selector wafer SA2 and are selected to feed the counter/display circuit on functions Frequency, Multi-period and Count : the signals are also available at wafer SA5 to feed the Frequency Divider chain (treated in Section 5.2.4) on both Timing functions.

5.2.6 Counter Chain and Display

The signals at function selector wafer SA2 (i.e. gated signals on functions Frequency, Multi-period and Count: or for both Timing functions, signals selected from the frequency divider chain by SB1 rotor) are fed to the counter chain comprising cascade-connected decade counters. Each counter board houses and drives one of the digital indicator tubes used to display the count.

Note: In instruments with display storage facility (Drg. ES67/21) the counter chain comprises counter boards types 66/730 and 66/710M. Each board contains a decade counter and a count-storage circuit with digital indicator. When the Display switch SK is set to 'Normal', terminal points H of the counter boards are held at earth potential and the storage circuits and display follow the progression of the count: when the switch is set to 'Store' the count information is passed to the storage and display circuit only when TP11 of stage 66/602 swings positive at the end of a gating period. The information thus acquired by the storage circuit is retained and displayed until new information is received at the end of the next gating period.

The display system includes three decimal point neon-lamps (V1-3). In relation to the counter chain shown at the top of the diagram, the inter-counter spaces as read from left to right are occupied by the lamps V3, V2, V1 respectively.

The presentation of a decimal point occurs only on Frequency and the two Timing functions and is controlled primarily by function selector wafer SA6: the appropriate lamp is selected by range-switch wafer SB1 (on Frequency function) or by wafer SB2 (on the two Timing functions). The selected lamp is illuminated by the +235 V output at pin 3 of the power unit.

No decimal point is presented in the display when the range switch (SB) is set to the

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* For specification of input signals see Section 2.6

first position.

5.2.7 Display Time and Reset Circuit

The Gate, Control and Reset stage type 66/602 employs Display Time selector-switch SJ, Display Time control RV2 and Reset push-button SH. Operation of the reset circuit is treated in circuit description sheet CD.66/602, near the rear of this manual.

The reset pulse produced at TP5 (upon depression of push-button SH or automatically when switch SJ is set to 'Auto') is applied to terminal points E of the counter chain so that each counter stage is reset to the zero condition.

Note: On instruments with the display storage facility, the reset pulse does not cause a change in the display if switch SK is set to 'Store'.

The pulse also serves to reset the stages of the frequency divider chain. At each stage the pulse is received at TP4 and, depending upon the setting of function selector wafer SA8, at either TP5 or TP6. For functions Frequency and Multi-period the chain is set to the 9999999 condition so that the first input pulse received (via SA5 rotor) triggers the chain to the zero condition, thereby producing a pulse at SB1 rotor which (supplied via SA3) opens the gate. For both Timing functions the chain is reset to the zero condition. Although on Count function the divider chain is not employed, it is again reset to zero.

Function selector wafer SA7 serves to hold the unused reset line of the divider chain stages (i.e. TP5 or TP6) at the required -6 V level.

5.2.8 Interpretation of 'Signal-flow/Function' Diagram S65/22

Diagram S65/22 indicates the use of each wafer of the Function Selector (switch SA) and enables signal flow to be easily traced through the main circuit diagram. As an example the diagram or chart will be followed for Position 1 of the Function Selector.

Reading across the chart, the function for Position 1 is indicated in the first square to the right and is 'Frequency'. The next square indicates that rotor SA1 (which is the Gate Input selector) receives signals from input socket SKTA after they have passed through the pulse shaper stage. Proceeding to the right, SA2 rotor receives the signals which pass through the gate while it is held 'open' and feeds them to the counter/display chain. Rotor SA3 feeds Start signals to the gate control stage: the 1st negative pulse from SB1 rotor opens the gate, whilst the 2nd pulse, received by Rotor SA4, closes it. (The frequency of signals at rotor SB1 of the Range Switch is dependent upon the switch setting; the frequencies for the various positions are listed on diagram S65/22. Should this switch be set to position 7 the frequency would be 1 Hz; the period or interval between consecutive pulses would therefore be 1 second, i.e. the time for which the gate

would be held 'open').

Rotor SA5 receives the 1 MHz output of the oscillator stage which gives rise to the frequencies at Range Switch wafer SB1 referred to above and treated in Section 5.2.4.

Proceeding further to the right of the diagram, it is seen that Function Selector rotors SA6, SA7 and SA8 deal with the decimal point lamp circuit and reset circuit respectively.

Double Decade type 66/100 (Drg. ES66/29)

In this circuit VT1-8 form the first decade and VT9-16 the second. Since the two decades are identical except for the termination point numbers used for the respective inputs and outputs (these are indicated on the left of diagram ES66/29) circuit description will be confined to the first decade.

The decade comprises four bi-stables (e.g. VT1-2; VT3-4, etc.) and is in the zero condition when transistors VT2, 4, 6 & 7 are conductive. The circuit is triggered by negative-going input signals applied to TP15* and operation is in 1-2-4-8 code.

The table below indicates the state of the decade for each count condition.

(N.B. For the respective bi-stables, 'o' represents conduction by VT2, 4, 6 & 7)
For the respective bi-stables, '1' represents conduction by VT1, 3, 5 & 8)

Bi-stable:-	VT1-2	VT3-4	VT5-6	VT7-8
Condition 0 :	o	o	o	o
Condition 1 :	1	o	o	o
Condition 2 :	o	1	o	o
Condition 3 :	1	1	o	o
Condition 4 :	o	o	1	o
Condition 5 :	1	o	1	o
Condition 6 :	o	1	1	o
Condition 7 :	1	1	1	o
Condition 8 :	o	o	o	1
Condition 9 :	1	o	o	1

Between count conditions 0 and 9, whenever the first bi-stable is triggered from '1' to 'o' a negative-going trigger-signal is passed to the next bi-stable; the action is the same for the second and third bi-stables. When the fourth bi-stable is triggered from 'o' to '1' diode MR18, previously reverse-biased, then serves to close diode-resistor gate R9-MR17 & 18. Therefore no trigger signal passes to the second bi-stable at the count transition nine to zero; but the final bi-stable (which is in the '1' state at count condition 9) is triggered to 'o' by the negative-going signal produced at VT2 collector and passed via C16. As the decade thus reverts to the zero count condition, a negative-going 'output signal' is produced at TP13 (VT7 collector).

Three reset lines (common to both decades) are provided. The 'Reset 0' line (TP5) and

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* TP = Termination point

'Reset 9' line (TP6) are necessary since opposite states of the first and fourth bi-stables are required to represent the respective count conditions 0 and 9. The remaining bi-stables (2nd & 3rd) are required in the same state for both conditions and are connected to the line marked 'Reset' (TP4).

The reset lines are normally held at -6V*. The decade is set to zero when the 'Reset' and 'Reset O' lines are momentarily raised more positive than +4V*; it is set to 9 when the 'Reset' and 'Reset 9' lines are momentarily raised more positive than +4V*.

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* With respect to TP3

Decade Divider type 66/140 (Drg. ES66/36)

The decade comprises four bi-stables (e.g. VT1-2; VT3-4, etc.) and is in the zero condition when transistors VT2, 4, 6 & 7 are conductive. The circuit is triggered by negative-going input signals applied to TP15 and operation is in 1-2-4-8 code.

The table below indicates the state of the decade for each count condition.

(N.B. For the respective bi-stables, 'o' represents conduction by VT2, 4, 6 & 7)
For the respective bi-stables, '1' represents conduction by VT1, 3, 5 & 8)

Bi-stable:-	VT1-2	VT3-4	VT5-6	VT7-8
Condition 0 :	o	o	o	o
Condition 1 :	1	o	o	o
Condition 2 :	o	1	o	o
Condition 3 :	1	1	o	o
Condition 4 :	o	o	1	o
Condition 5 :	1	o	1	o
Condition 6 :	o	1	1	o
Condition 7 :	1	1	1	o
Condition 8 :	o	o	o	1
Condition 9 :	1	o	o	1

Between count conditions 0 and 9, whenever the first bi-stable is triggered from '1' to 'o' a negative-going trigger signal is passed to the next bi-stable; the action is the same for the second and third bi-stables. When the fourth bi-stable is triggered from 'o' to '1' diode MR10, previously reverse-biased, then serves to close diode-resistor gate R9-MR9 & 10. Therefore no trigger signal passes to the second bi-stable at the count transition nine to zero; but the final bi-stable (which is in the '1' state at count condition 9) is triggered to 'o' by the negative-going signal produced at VT2 collector and passed via C16. As the decade thus reverts to the zero count condition, a nagative-going 'output signal' is produced at TP13* (VT7 collector).

Three reset lines are provided. The 'Reset 0' line (TP5) and 'Reset 9' line (TP6) are necessary since opposite states of the first and fourth bi-stables are required to represent the respective count conditions 0 and 9. The remaining bi-stables (2nd & 3rd) are required in the same state for both conditions and are connected to the line marked 'Reset' (TP4).

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* TP = Termination point

The reset lines are normally held at -6V*. The decade is set to zero when the 'Reset' and 'Reset O' lines are momentarily raised more positive than +4V*; it is set to 9 when the 'Reset' and 'Reset 9' lines are momentarily raised more positive than +4V*.

* With respect to TP3

Power Supply type 66/210 (Drg. E66/98)

Mains:

The mains supply received at inter-connecting plug PLA (pin 7 neutral: pin 8 live) is applied to transformer T1 whose twin primary windings should have been appropriately linked for the supply voltage (i.e. series connected for 200/250 V a.c. supplies: parallel connected for 100/125 V a.c. supplies).

± 6 V d.c. Supplies:

Two stabilized supplies (+6V* at pin 1, -6V* at pin 2) are derived from the centre-tapped secondary winding of T1 by means of full-wave-rectifier/stabilizer circuits MR2 & 3/VT3 - 5 and MR4 & 5/VT1 & 2 respectively.

The reverse breakdown voltage of Zener diode MR6 serves as reference potential for the +6V stabilizing circuit (VT3-5) whose output is presettable by means of voltage control RV1. Corresponding components MR7 and RV2 are provided for the -6V stabilizing circuit.

For each stabilizer, the Zener diode chain (e.g. MR6-RV1-R8) is connected between the +6V and -6V lines, rather than between one 6V line and chassis-earth, so that sufficient supply voltage is ensured to maintain the required breakdown condition of the diode.

235V d.c. supply

A 235V d.c. supply presented between pin 3 (positive) and pin 9 (chassis-earth : negative) of plug PLA is derived from the 210V transformer-winding by the circuit of rectifier MR1: the output is provided as anode-supply for neon digital indicator tubes.

12.6V a.c. Output

The output of the 12.6V secondary winding of transformer T1 is available between pins 5 and 6 of plug PLA; it is provided to power the oven of a temperature controlled crystal oscillator.

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* With respect to chassis-earth pin 9

Pulse Shaper type 66/301 (Drg. E68/9)

Complementary emitter followers VT1 and VT3 operate with constant current source VT2 (current approx. 1mA determined by ratio R4:R5) and present a high input impedance to signals received at TP16*. Components MR1 and MR2 function as clamping diodes in the event of excessive input amplitudes; R2 and MR3 contribute to temperature compensation, whilst R6-C2 and R10-C4 & 5 with R27-C10 provide de-coupling at the +6V and -6V supply lines respectively.

Signals produced at VT3 emitter pass via RV2 wiper and MR5 to the d.c. -coupled cascade amplifier comprising VT6 (of long-tailed-pair VT6-VT7) and VT5. De-coupling is provided by R16-C7 and R22-C9. The amplifier output from VT5 collector is passed via emitter follower VT8: d.c. -feedback is applied to the input circuit via R18 and emitter follower VT4.

The long-tailed-pair is balanced by adjustment of RV1 and RV2 treated at the end of this description.

Signals from VT8 operate Schmitt trigger stage VT9-VT10 (VT9 normally conductive, VT10 non-conductive). The output of the Schmitt trigger, or shaper, is applied via capacitor C12 to pulse-amplifier/inverter VT11 at whose collector (TP6) a positive output pulse is produced as the shaper is triggered.

The latter pulse is also applied, via R37, to inverter VT13 which provides the inverted or negative pulse at TP8. This occurs providing input TP5 is held at the 'non-inhibit' level (i.e. approx. 0V**). Should TP5 be held at the 'inhibit level' (i.e. more positive than +2.5V**) VT12 conducts to hold VT13-base at approximately 0V and the negative pulse is therefore not produced at TP8.

Separate 0V supply lines are provided (at TP3 & 4 and TP13 & 14) so that the 0V line of the input emitter follower and associated amplifier may be separately earthed at the signal input socket of the instrument: thus noise currents at the input of the stage are separately earthed.

Resistor Replacement & Potentiometer Adjustment

Replacement of R2:-

The required value of R2, which is selected during test, is dependent upon the gain of the particular transistors used in positions VT1 and VT2. Therefore should either transistor be changed (i.e. because of a fault condition) the following procedure should be carried out.

Note: For access to the preset controls the stage should be raised above the top of the instrument by mounting it on an extension connector (Venner Part No. X50999/1).

i) Set the Sensitivity control of the instrument to 'POWER OFF' and ensure that the stage is receiving no input signals.

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* TP = Termination point
** With respect to TP3 & 4

ii) Remove the wire link between Pins B and C shown on circuit diagram E68/9: see also board layout diagram BL66/301.

iii) Remove resistor R2; then temporarily connect a 100kΩ potentiometer (set to approx. mid-track) between Pins D and E.

iv) Three d.c. voltmeters (numbered 1, 2, 3 for reference) are required*; connect these as follows :-

Voltmeter - 1: between termination point 16 (meter positive) and termination points 13 and 14 (meter negative).

Voltmeter - 2: between Pin B (meter negative) and Pin C (meter positive).

Voltmeter - 3: between VT5-collector (meter negative) and VT7-collector (meter positive).

v) Switch ON the supply to the instrument and set the Sensitivity control to 'MAX'.

vi) Adjust the 100kΩ potentiometer for 0V indication on Voltmeter - 1.

vii) Adjust control RV1 for 0V indication on Voltmeter - 3 and adjust control RV2 for 0V indication on Voltmeter - 2.

viii) Since the functions of RV1, RV2 and the 100kΩ potentiometer will be to some extent inter-dependent, it may be necessary to re-adjust the controls referred to in 'vi' and 'vii' several times before 0V is indicated concurrently by all voltmeters.

ix) Remove Voltmeters 2 and 3. Reconnect one meter (as Voltmeter - 4) between Pin A (meter positive) and termination points 13 and 14 (meter negative). The indication given by Voltmeter - 4 should lie between 2.65V and 3.15V when the value of R30 is 150Ω or 2.55V and 2.85V when R30 is 100Ω (see Components List CL.66/301).

x) Voltmeter - 1 should still indicate 0V (if not, repeat the method from procedure 'vi' onwards).

xi) Set the Sensitivity control to 'POWER OFF' and remove Voltmeter - 4.

xii) Without altering its setting, carefully remove the 100kΩ potentiometer and measure the resistance between its two terminals just disconnected. Select a high stability ± 1% (¼W) resistor of the value just measured (or use ± 1% H.S. resistors in parallel to give this value) and solder it between Pins D and E.

xiii) Set the Sensitivity control to 'Max' and check that Voltmeter - 1 indicates 0V; if the voltage is not zero it is probable that the value of the substituted resistor is slightly incorrect the general procedure should therefore be repeated.

xiv) Set the Sensitivity control to 'POWER OFF' then resolder a link between Pins B and C.

Adjustment of Preset Potentiometers RV1 and RV2

Should the settings of RV1 and RV2 be inadvertently altered, reset these controls by carrying out certain procedures given under 'Replacement of R2' as indicated below.

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* Suitable type:- Universal AVO Meter Model 8 set to 10V d.c. range.

Carry out procedures: i and ii

iv (but connect only Voltmeters 2 and 3)

v and vii

viii (but ignore reference to 100kΩ potentiometer
and to procedure vi)

ix and xiv.

Oscillator type 66/512 (Drg. ES66/24)

Oscillator:-

A crystal controlled sinewave oscillator is formed by the circuit containing VT7 and VT8. The external crystal and trimmer capacitor are connected in series between TP6** and TP 7: the trimmer is preset for the required oscillator frequency (2 MHz) whilst control RV1 is present for maximum distortion-free output at TP8.

Pulse Shaper & Inhibit Circuit:-

Signals applied to TP10 (normally the oscillator output or signals from an external frequency source) pass via inverter/amplifier VT6 to Schmitt-trigger/pulse-shaper VT3-VT4.

Rectangular pulses, at the input-frequency, occur at pulse shaper output TP13 providing an 'inhibit signal' is not present at TP12.

The inhibit input is normally held at approximately OV* (inhibit off). However, to prevent shaper output pulses from occurring during the reset period, the inhibit level (more positive than +2.5V*) is applied to TP12: transistor VT5 therefore conducts to hold VT3 collector (TP13) at approximately chassis-earth potential.

Frequency Divider:-

The circuit containing transistors VT1 and VT2 is that of a binary. The junction R8-MR3 of the binary is not connected to the -6V rail (TP1) but is available as a 'command signal' input at TP14. This input is held at -6V when the circuit is required to operate as a frequency divider, in which case negative-going signals from the preceding pulse shaper (i.e. from VT3 collector) pass alternately via C1-MR1 (to cut-off VT1) and C4-MR2 (to cut-off VT2) and trigger the binary. Square-wave signals of frequency half that of the shaper output are therefore produced at binary output TP16 and at complementary output TP15.

If frequency division is not required, command input TP14 is held at +6V. In this case MR3 and VT2 are normally conductive; transistors VT2 and VT1 operate as cascade-connected inverter/amplifiers for negative pulses produced at VT3-collector and passed via C4.

** TP = Termination point.
* Voltage level with respect to TP3.

Gate Control and Reset Circuit type 66/602 (Drg. ES66/77)

Gate-control Circuit:-

This circuit comprises binaries VT4-5 and VT6-7, in inter-lock connection, and inhibit-transistor VT14 which is normally held non-conductive by the inhibit signal circuit (VT10-11) treated later in this section. Gate control signals are produced at TP11**, i.e. the output of the second binary.

Both binaries are reset to the 0-condition (i.e. VT4 & VT6 conductive) upon receipt of a positive 'reset pulse' at the junction R9-R16; generation of this pulse is treated later.

The first negative-going signal received at Start Input TP12 triggers binary VT4-VT5 which in turn triggers binary VT6-VT7: both binaries are thus triggered to the 1-condition. The Gate Control output swings from the 'gate-closed-level' (approx. +5.5V*) to the 'gate-open level' (approx. OV*).

The second binary (VT6-7) is triggered back to the O-condition upon receipt of the next negative-going signal at Stop Input TP10; the output at TP11 therefore reverts to the 'gate-closed level'.

Henceforth the binaries are insensitive to further signals via TP10 and TP12 until they have been reset. Transistor VT14 is held conductive by the 'inhibit signal' (which is initiated coincident with the reset signal) and ensures that the binaries cannot again be triggered (to open the main signal gate; treated below) until after associated counter circuits have been reset.

Signal Gate:-

This circuit contains VT1-3 & VT16. Control signals from TP11 are received at control input TP16.

The signals, passed via high input-impedance buffer amplifier/inverter VT1, operate control transistor VT2 of the transistor AND-gate comprising VT2-VT3. The gate is open (i.e. VT2 conductive) while TP16 is held at approximately OV*; for this period (or gating time) signals received at TP14 pass via emitter follower VT16 and the a.c-coupled gate, and are hence presented inverted at output TP13.

** TP = Termination point
* Voltage level with respect to TP3

Print Command Pulse (P.C.P.) & Display Time Circuit:-

The negative-going potential change produced at VT1-collector (to close gate VT2-VT3) is available at TP15 as a 'print command signal' for the control of data logging equipment: it also passes via C12 and triggers display time monostable VT8-VT9. The monostable remains in the new condition (VT8-VT9 cut-off) for the display time which is dependent upon the time constant C13 x (R25+R26+ external resistance between TP9 & TP3). At the end of this period the circuit reverts to the stable state; a negative-going pulse is passed via C14, and C13 is charged linearly by VT8 collector current.

The latter occurs providing that no potential is applied to 'hold input' TP8; however, with VT9-collector connected via R29 and TP8 to the +6V* supply line, monostable VT8-VT9 cannot be triggered via C12. Therefore, to initiate reset action it is necessary to operate the following circuit (normally triggered via C14) by means of a push-button as described below.

Inhibit & Reset Circuits:-

These circuits incorporate transistors VT10 to VT13. The negative pulse received via C14 triggers 'inhibit monostable' VT10-VT11, whereupon Inhibit Output TP7 swings from approximately OV* to the 'inhibit level', i.e. more positive than +2.5V*, due to the action of emitter follower VT15. (In general this output is used to inhibit the normal operation of certain remote circuits until they have been reset, thus undesirable transient circuit-conditions are prevented. The signal produced at VT10-collector also operates VT14 treated above).

The monostable may also be triggered by a negative-going signal received via terminal point TP4.

As the monostable is triggered (i.e. as VT10 is cut-off and VT11 conducts) a negative-going signal is delivered, via C20, to VT12 and causes a positive 'reset pulse' to be produced at output TP5 (pulse width approx. 0.2ms): the pulse resets gate control binaries VT4-5 and VT6-7. The duration of the 'inhibit signal' is approximately 20ms (dependent upon time constant C16 x R31: this provides sufficient time for display-time-monostable capacitor C13 to be completely re-charged); the inhibit monostable then reverts to the stable state.

The inhibit monostable may be triggered manually. Depression of a normally open push-button connected between TP6 and TP2 presents a positive-going trigger pulse (via C19) to VT11-base and initiates the generation of both the inhibit and reset pulses: capacitor C18 serves as contact bounce suppressor for the remote push-button.

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* Voltage level with respect to TP3.

The particular reset-pulse-output-circuit of VT12-VT13 is employed to provide the necessary impedances between reset output TP5 and the +6V and -6V lines (at TP2 & TP1 respectively). In the normal condition, to maintain the reset lines of remote circuits connected to TP5 (e.g. decade counters) at the appropriate level approx. -5.5V*, a low impedance path (provided by VT12: normally conductive) is required between TP5 and the -6V line; whilst a high impedance (provided by R41; VT13 being non-conductive) is required between TP5 and the +6V line. However, during the reset period a low impedance output to the +6V line is required to raise the potential of the reset line to a sufficiently high value for the resetting of decade units etc: this is provided by the emitter follower action of VT13.

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* With respect to TP3.

Low Speed Counter type 66/710 (Drg. ES66/91)

Positive-going signals* received at terminal point R trigger integrated circuit X1 which functions as a 1-2-4-8 b.c.d. decade counter.

A positive-going 'carry signal', produced by the decade count transition 9 to 0 is available at terminal point P for application to a subsequent cascade connected counter stage.

The decade provides 1-2-4-8 b.c.d outputs at pins 5, 4, 3 & 2 respectively; these operate integrated decoder-driver X3. The ten mutually exclusive outputs of the latter stage serve to control neon digital indicator tube V1 whose +235V anode-supply is received at terminal point T. A numeral-cathode glows, to display the count condition of the decade, when its control line swings negative to approximately chassis-earth potential.

Both integrated circuits are supplied by approximately +5V obtained, via voltage dropping diode MR1, from a 6V supply received between terminal points C (OV) and B (+6V): decoupling is effected by capacitor C1.

The decade is reset to the zero condition upon receipt of a positive pulse* (approx. +5V) at terminal point E: clamping diode MR2 is employed to protect the integrated decade against negative potentials* presented to this terminal point.

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* With respect to terminal point C.

Low Speed Counter & Store type 66/710M (Drg. ES66/89)

Positive-going signals* received at terminal point R trigger integrated circuit X1 which functions as a 1-2-4-8 b.c.d. decade counter.

A positive-going 'carry signal', produced by the decade count transition 9 to 0 is available at terminal point P for application to a subsequent cascade connected counter stage.

The decade provides 1-2-4-8 b.c.d outputs at pins 5, 4, 3 & 2 respectively; these feed the data inputs of integrated buffer-storage unit X2. The input information is accepted by the latter stage throughout the interval that terminal point H is held at the 'transfer level' (i.e. approx. OV*): when it is held at the 'store level' (i.e. approx.+4V*) information in the stage is retained, therefore no change occurs in the store until a transfer signal is received.

When data logging outputs are required, current limiters R8 to 11 are fitted so that the 1-2-4-8 b.c.d. information at connections 15, 12, 2 & 5 of the buffer-storage stage is made available at terminal points K to N.

The 1-2-4-8 b.c.d. outputs from connections 13, 10, 4 & 7 of the buffer-storage stage operate integrated decoder-driver X3. The ten mutually exclusive outputs of the latter stage serve to control neon digital indicator tube V1 whose +235V anode-supply is received at terminal point T. A numeral-cathode glows, to display the count information within the buffer-storage stage, when its control line swings negative to approximately OV*.

The integrated circuits are supplied by approximately +5V obtained, via voltage dropping diode MR1, from a 6V supply received between terminal points C (OV) and B (+6V): decoupling is effected by capacitor C1.

The decade is reset to the zero condition upon receipt of a positive pulse* (approx. +5V) at terminal point E: clamping diode MR2 is employed to protect the integrated decade against negative potentials* presented to this terminal point.

---

* With respect to terminal point C.

High Speed Counter type 66/720 (Drg. ES66/92)

Negative-going signals* received at terminal point R trigger integrated circuit X1 which functions as a 1-2-4-8 b.c.d. decade counter.

Four NAND-gates of integrated circuit X2 are employed as inverters for the 1-2-4-8 b.c.d. outputs of the decade.

A positive-going 'carry signal', initiated by the decade count transition 9 to 0 is produced at terminal point P for application to a subsequent cascade connected counter stage.

The four outputs of the inverter circuit feed integrated decoder-driver X3. The ten mutually exclusive outputs of the latter stage serve to control neon digital indicator tube V1 whose +235V anode supply is received at terminal point T. A numeral cathode glows, to display the count condition of the decade, when its control line swings negative to approximately chassis-earth potential.

The integrated circuits are supplied by approximately +5V obtained, via voltage dropping diode MR1, from a 6V supply received between terminal points C (OV) and B (+6V): de-coupling is effected by capacitor C1.

The decade is reset to the zero condition upon receipt of a positive pulse* (approx. +5V) at terminal point E: clamping diode MR2 is employed to protect the integrated decade against negative potentials* presented to this terminal point.

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* With respect to terminal point C.

High Speed Counter & Store type 66/730 (Drg. ES66/90)

Negative-going signals* received at terminal point R trigger integrated circuit X1 which operates as a decade counter and provides 1-2-4-8 b.c.d. outputs at connections 12, 9, 8 & 11 respectively.

The output of connection 11 operates inverter/amplifier VT3 so that, coincident with the decade count transition 9 to 0, a positive-going 'carry signal' is produced at terminal point P for application to a subsequent cascade connected counter stage.

The b.c.d. outputs of the decade feed the data inputs of integrated buffer-storage unit X2. The input information is accepted by the latter stage throughout the interval that terminal point H is held at the 'transfer level' (i.e. approx. OV*): when it is held at the 'store level' (i.e. approx. +4V*) information in the stage is retained, therefore no change occurs in the store until a transfer signal is received.

Terminal point H may be externally connected to the OV line if storage action is not required: however, with no such connection it is normally held at the 'store level' by transfer-pulse shaper circuit VT1 & 2. When the transfer-control input, terminal point J, is held at approximately OV* capacitor C2 is discharged via VT1 & MR3. Transistor VT2 is normally held cut-off, but when terminal point J is taken positive to approximately +5V* C2 charges via R4 & VT2-base so that a narrow negative-going transfer pulse is produced at VT2-collector and new count information is accepted by the buffer-storage unit.

When data logging outputs are required, current limiters R11 to 14 are fitted so that the 1-2-4-8 b.c.d. information at connections 10, 7, 4 & 13 of the buffer-storage stage is made available at terminal points K to N.

The circuit of VT4 is also fitted : each positive-going signal at VT1-emitter operates the pulse shaper circuit of VT4 which produces a negative-going print command pulse (for the control of remote data logging equipment) at terminal point D.

The 1-2-4-8 b.c.d. outputs from connections 12, 5, 2 & 15 of the buffer storage stage operate integrated decoder-driver X3. The ten mutually exclusive outputs of the latter stage serve to control neon digital indicator tube V1 whose +235Vanode-supply is received at terminal point T. A numeral-cathode glows, to display the count information within the buffer-storage stage,

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* With respect to terminal point C.

when its control line swings negative to approximately OV*.

The integrated circuits are supplied by approximately +5V obtained, via voltage dropping diode MR1, from a 6V supply received between terminal points C (OV) and B (+6V): decoupling is effected by capacitor C1.

The decade is reset to the zero condition upon receipt of a positive pulse* (approx. +5V) at terminal point E : clamping diode MR2 is employed to protect the integrated decade against negative potentials* presented to this terminal point.

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* With respect to terminal point C

Double Decade type 66/100 (Drg. ES66/29)

Resistors:	Value	Description	Venner Part No.
R1, 8, 9, 34, 41, 42	3.3kΩ ±5% ¼W	Carbon	X50500/61/P
R2, 5, 11, 14, 19, 22, 27, 30, 35, 38, 44, 47, 52, 55, 60, 63	1kΩ " "	"	X50500/49/P
R3, 4, 12, 13, 20, 21, 28, 29, 36, 37, 45, 46, 53, 54, 61, 62	4.7kΩ " "	"	" /65/P
R6, 7, 15, 16, 23, 24, 31, 32, 39, 40, 48, 49, 56, 57, 64, 65	18kΩ " "	"	" /79/P
R10, 17, 18, 25, 26, 33, 43, 50, 51, 58, 59, 66	6.8kΩ " "	"	" /69/P
Capacitors:			
C (1-34)	47pF ±5%	Ceramic N750	Y50505/4
Transistors:	**Type**		
VT (1-16)	U15718/2		X20638/55
Diodes:			
MR (1-20)	U2973/2		X20639/31/P

Ref:- P2038: 1/1A

Note: The stage may be supplied fitted with the above or equivalent types of components.

Decade Divider type 66/140 (Drg. ES66/36)

Resistors:	Value	Description	Venner Part No.
R1, 8, 9, 10, 17, 18, 25, 26, 33	3.3kΩ ±5% ¼W	Carbon	X50500/61/P
R2, 5, 11, 14, 19, 22, 27, 30	560Ω " "	"	" /43/P
R3, 4, 12, 13, 20, 21, 28, 29	2.2kΩ " "	"	" /57/P
R6, 7, 15, 16, 23, 24, 31, 32	10kΩ " "	"	" /73/P
Capacitors:			
C(1-16)	47pF ±5%	Ceramic N750	Y50509/4
Transistors:	**Type**		
VT(1-8)	U15718/2		X20638/55
Diodes:			
MR(1-10)	U2973/2		X20639/31/P

Ref:- P2073: 1/1-

Note: The stage may be supplied fitted with the above or equivalent types of components.

Power Supply type 66/210 (Drg. E66/98)

Resistors:	Value	Description	Venner Part No.
R1	470kΩ ±5% ¼W	Carbon	X50501/17/P
R2	330Ω " "	"	X50500/37/P
R3	3Ω ±10% 3W	Wire wound	Z21092/3
R4	820Ω ±5% ¼W	Carbon	X50500/47/P
R5	2.2kΩ " "	"	" /57/P
R6	0.5Ω ±10% 3W	Wire wound	Z21092/6
R7	1kΩ ±5% ¼W	Carbon	X50500/49/P
R(8-10)	1.5kΩ " "	"	" /53/P
R11	270Ω " "	"	" /35/P
Resistors Variable:			
RV1,2	1kΩ ±20% ¼W	Carbon Lin.	X20999/58
Capacitors:			
C1	8μF (350V)	Electrolytic	Y20643/50
C2	0.1μF (400V)	Polyester	X23914/45
C3	4000μF (25V)	Electrolytic	X20643/51
C4	1250μF (25V)	"	" /52
C5,6	120μF (16V)	"	Y50506/10
C7,8	1000pF ±10%	Ceramic (High K)	Y50509/11
C9,10	8μF (10V)	Electrolytic	Y50506/2
	Alternative: 15μF (20V)	Tantalum	Y22776/20
Diodes:	Type		
MR1	BYX10		X20639/35/P
MR(2-5)	IN4001		" /45/P
MR6,7	BZY88/C4V7		" /33/P
Transistors:			
VT1	2N4037		X20638/82
VT2	V435		" /72
VT3,4	U15718/2		" /55
VT5	40250		" /60
Fuses:	Rating		
FS1	100mA		Z26413/1
FS2,3	1.5A		" /2

Transformer:		Venner Part No.
T1		Y51043

Plug:	Type	
PLA	B9A	Z50402

Ref:- P2125:3/1E/2D/3-

Note: The stage may be supplied fitted with the above or equivalent types of components.

Pulse Shaper type 66/ 301 (Drg. E68/9)

Resistors:	Value	Description	Venner Part No.
R1	68kΩ ±5% ¼W	Carbon	X50500/93/P
R2	Selected*		--
R3, 36, 41	470Ω ±5% ¼W	Carbon	X50500/41/P
R4	8.2kΩ ±2% ¼W. HS	Metal Oxide	X50502/24/P
R5	15kΩ " " "	" "	" /26/P
R6, (10-12), 17, 23, 42	100Ω ±5% ¼W	Carbon	X50500/25/P
R7	1.8kΩ " "	"	" /55/P
R8, 35	1.2kΩ " "	"	" /51/P
R9, 13, 37	2.7kΩ " "	"	" /59/P
R14	27kΩ ±2% ¼W. HS	Metal Oxide	X50502/62/P
R15	4.7kΩ ±5% ¼W	Carbon	X50500/65/P
R16	220Ω " "	"	" /33/P
R18	43kΩ ± 2% ¼W. HS	Metal Oxide	X50502/66/P
R19, 20	2.2kΩ ±5% ¼W	Carbon	X50500/57/P
R21	33Ω " "	"	" /13/P
R22	330Ω " "	"	" /37/P
R24	5.6kΩ " "	"	" /67/P
R25, 28	390Ω " "	"	" /39/P
R26	270Ω " "	"	" /35/P
R27	10Ω " "	"	" /1/P
R29	1kΩ " "	"	" /49/P
R30	100Ω " "	"	" /25/P
	or 150Ω ** " "	"	" /29/P
R31	15kΩ " "	"	" /77/P
R32	680Ω " "	"	" /45/P
R33	560Ω " "	"	" /43/P
R38	3.3kΩ " "	"	" /61/P
R39	22kΩ " "	"	" /81/P
Resistors Variable:			
RV1	1kΩ ±20% ¼W	Carbon Lin.	X20999/58
RV2	1kΩ ± 10% 1W	Wire wound	" /78

Capacitors			
C1	47pF± 5%	Ceramic N750	Y50509/4
C2, 4, 8	33μF (10V)	Tantalum	Y22776/13
C3, 12	22pF ±10%	Ceramic N220	Y50509/2
C5, 15	1000pF ±10%	Ceramic (High K)	Y50509/11
C6, 7, 9, 10	82μF (6.3V)	Tantalum	Y50506/4
C11	10pF ±5%	Ceramic NPO	Y50509/1
C14	0.1μF ±10% (250V)	Polyester	X23914/27

*Value within range approx. 50kΩ to 150kΩ

** Preferred value 100Ω

Diodes:	Type	Venner Part No.
MR (1-4), (6-8)	U2973/2	X20639/31/P
MR5	BZY88/C5V6*	" /54/P
MR9	1N4009	" /41/P

Transistors:

VT1, (5-10), 12, 13	U15718/2	X20638/55
VT2, 4	BC108	" /71
VT3, 11	V405A	" /65

Note: The current gain (α') of transistors in this stage should be as indicated below; colours relate to the Venner transistor-colour-spot code which is also given.

VT1 : Pink/Green (or higher gain group)
VT2,3,4: Pink (or higher gain group)
VT5, 13: Any colour/s (but not mixed gain groups)
VT(6-10) : Pink or higher gain groups (but not mixed)
VT11,12: Any colour/s

Code:-

Colour-spot/s	:	Gain Group
Red	:	28-40
Yellow	:	41-50
Green	:	51-60
White	:	61-70
Pink	:	71-90
Pink/Yellow	:	91-110
Pink/Green	:	111-150
Pink/White	:	151-170
Pink/White/White	:	Over 170

Ref:- P2195:2/1B/2A.

* Specially selected and available under the Venner Part number quoted.

Note: The stage may be supplied fitted with the above or equivalent types of components.

Oscillator type 66/512 (Drg. ES66/24)

Resistors:	Value	Description	Venner Part No.
R1, 3, 4, 7, 12	2.2kΩ ±5 % ¼W	Carbon	X50500/57/P
R2, 5, 19	470Ω " "	"	" /41/P
R6, 8, 15, 25	22kΩ " "	"	" /81/P
R9	8.2kΩ " "	"	" /71/P
R10	680Ω " "	"	" /45/P
R11, 20	1kΩ " "	"	" /49/P
R13, 28, 32	10kΩ " "	"	" /73/P
R14, 29	100Ω " "	"	" /25/P
R16	18kΩ " "	"	" /79/P
R17, 30	3.3kΩ " "	"	" /61/P
R18	5.6kΩ " "	"	" /67/P
R21	33kΩ " "	"	" /85/P
R22	150kΩ " "	"	X50501/5/P
R23	47kΩ " "	"	X50500/89/P
R24	330Ω " "	"	" /37/P
R26	68Ω " "	"	" /21/P
R27	15kΩ " "	"	" /77/P
R31	27kΩ " "	"	" /83/P

Resistor Variable:

RV1	5.6kΩ ±20 % ¼W	Carbon Lin.	X20999/55

Capacitors:

C(1-4)	47pF ±5 %	Ceramic N750	Y50509/4
C5	56pF ±5 %	" "	" /5
C6	220pF ±10 %	" (High K)	" /8
C7	8μF (10V)	Electrolytic	Y50506/2
	Alternative: 15μF (20V)	Tantalum	Y22776/20
C8	22pF ±10%	Ceramic N220	Y50509/2
C9, 11, 17	0.1μF ±10%(250V)	Polyester	X23914/27
C10	0.0047μF ±10%	Metallised Film	" /40
C12	1000pF ±1 %	Polyester	" /41
C15	82pF ±5 %	Ceramic N560	Y50509/6

Transistors:	Type	
VT1, 2, 5, 7	U15718/2	X20638/55
VT3, 4, 8	BSY95A	" /56
VT6	BC108	" /71

Diodes:

MR (1-5)	U2973/2	X20639/31/P

Ref:- P2077: 1/1C

Note: The stage may be supplied fitted with the above or equivalent types of components.

Components List - - -

Diodes:	Type	Venner Part No:
MR (1-4),6,7	U2973/2	X20639/31/P
MR5	IN4009	" /41/P

Transistors

VT (1-8), (10-16)	U15718/2	X20638/55
VT9	V435	" /72

Note: VT4 & VT5 are to be a matched pair.
VT6 & VT7 " "
VT12 current gain not less than 71.

Ref:- P2109:2/1K/2B.

Note: The stage may be supplied fitted with the above or equivalent types of components.

Low Speed Counter type 66/710 (Drg. ES66/91)

Resistors:	Value	Description	Venner Part No.
R1	33kΩ ±2.5% 0.5W	Carbon	X50512/1/P
R(2-6)	2.2kΩ ±5% 0.25 W	"	X50500/57/P
Capacitor:			
C1	0.1μF ± 10% (250V)	Polyester	X23914/27
C2	47pF ± 5%	Ceramic	Y50509/4
Diodes:	**Type**		
MR1	U2973/2		X20639/31/P
MR2	IN4009		" /41/P
Integrated Circuits:			
X1	CμL 9958		X50520/7
X3	CμL 9960*		" /8
Display Tube:			
V1	XN12		Z50391/1

Ref:- P2132: 1/1 E

*Specially selected and available under the Venner part number quoted.
Note: The stage may be supplied fitted with the above or equivalent types of components.

Low Speed Counter & Store type 66/710M (Drg. ES66/89)

Resistors:	Value	Description	Venner Part No.
R1	33kΩ ± 2.5% 0.5W	Carbon	X50512/1/P
R2, 7	2.2kΩ ± 5% 0.25W	"	X50500/57/P
R(8-11)	1kΩ " "	"	" /49/P

Capacitor:			
C1	0·1μF ±10%(250V)	Polyester	X23914/27
C2	47pF ± 5%	Ceramic	Y50509/4

Diodes:	Type	
MR1	U2973/2	X20639/31/P
MR2	IN4009	" /41/P

Integrated Circuits:		
X1	CμL9958	Z50520/7
X2	CμL9959	" /6
X3	CμL9960*	" /8

Display Tube:		
V1	XN12	Z50391/1

Ref:- P2133: 1/1C

*Specially selected and available under the Venner part number quoted.
Note: The stage may be supplied fitted with the above or equivalent types of components.

High Speed Counter type 66/720 (Drg. ES66/92)

Resistors:	Value	Description	Venner Part No.
R1	2.2kΩ ±5% ¼W	Carbon	X50500/57/P
R2	33kΩ ±2.5% 0.5W	"	X50512/1/P

Capacitor:

C1	0.1μF ±10%(250V)	Polyester	X23914/27

Diodes:	Type	
MR1	U2973/2	X20639/31/P
MR2	IN4009	" /41/P

Integrated Circuits:

X1	SN 7490N	X50520/5
X2	SN 7400N	" /1
X3	C μL 9960*	" /8

Display Tube:

V1	XN12	Z50391/1

Ref:- P2130: 1/1A

*Specially selected and available under the Venner part number quoted.
Note: The stage may be supplied fitted with the above or equivalent types of components.

High Speed Counter & Store type 66/730 (Drg. ES66/90)

Resistors:	Value	Description	Venner Part No.
R1, 2, 4, 5, 8, 9,	2.2kΩ ±5% ¼W	Carbon	X50500/57/P
R3	470Ω " "	"	" /41/P
R6, (11-14)	1kΩ " "	"	" /49/P
R7	8.2kΩ " "	"	" /71/P
R10	33kΩ ±2.5% 0.5W	"	" /85/P
R15	3.3kΩ ±5% 0.25W	"	X50512/1/P X50500/61/P

Capacitors:			
C1	0.1μF ±10%(250V)	Polyester	X23914/27
C2, 4	560 pF ±10%	Ceramic (High K)	Y50509/10
C3	0.01μF ±10%(250V)	Polyester	X23914/34

Diodes:	Type	
MR1, 3, 4	U2973/2	X20639/31/P
MR2	IN4009	" /41/P

Transistors:		
VT1	V435	X20638/72
VT2, 3	U15718/2	" /55
VT4	BC108	" /71

Integrated Circuits:		
X1	SN7490N	Z50520/5
X2	CμL9959	" /6
X3	CμL9960*	" /8

Display Tube:		
V1	XN12	Z50391/1

Ref:- P2131: 2/1B/2A.

*Specially selected and available under the Venner part number quoted.
Note: The stage may be supplied fitted with the above or equivalent types of components.

Resistors:	Value	Description	Venner Part No.
R1, 2	100kΩ ± 5% ¼W	Carbon	X50501/1
R3	4.7kΩ " "	"	X50500/65
R4, 5	47kΩ " "	"	" /89
R6	1kΩ " "	"	" /49
R7	330kΩ " "	"	X50501/13
Resistors Variable:			
RV1	500kΩ ± 20% 2W	Carbon. Lin. with 2 pole switch	*
RV2	500kΩ ± 20% 2W	Carbon. Lin	X20999/54
Capacitors:			
C1	0.47μF ± 20% (400V)	Polystyrene	X23914/24
C2, 9	0.068μF (250V)	Polystyrene	" /36
C3, 4	0.0047μF ± 10%	Polystyrene	" /40
C5	47pF ± 5%	Ceramic N750	Y50505/4
C6	4-60pF (trimmer)	Air	Z21135/5
C7	0.1μF ± 10% (250V)	Polyester	X23914/27
C8 (a-c)	0.1+0.005+0.005μF (250V)	Suppressor capacitor	Z26102
C10	0.047μF ± 10% (250V)	Polyester	X23914/38
Diodes:	**Type**		
MR (1-4)	U2973/2		X20639/31

Switches:	Description		
SA	Function Selector	3 section 8 pole 5 position (Rotary)	Y50677
SB	Range Switch	3 section 3 pole 8 position (Rotary)	Y50678
SC	AC/DC Selector	2 pole 2 position (Slide)	Z27067/1
SD	Start Push-button	1 pair normally-open contacts	Z50393
SE	Stop Push-button	1 pair normally-open contacts	Z50393
SF	Crystal Reference Selector	2 pole 2 position (Slide)	Z27067/1
SG	Power Switch	2 pole ON/OFF	*
SH	Reset Push-button	1 pair normally-open contacts	Z50393
SJ	Display Time Switch	2 pole 2 position (Slide)	Z27067/1
SK**	Display Normal/Stored Selector	1 pole 2 position (Toggle)	Z51095

* RV1 ganged to switch SG : Common part No. X20999/53
** Not applicable to diagram ES67/20

Sockets:	Description	Venner Part No.
SKTA	A-Input Socket. (coax.)	X50508/4
SKTB	Std. Freq. socket (wander)	X20637/85
SKTC	Test socket (wander)	X20637/85
SKTD	Ext. Ref. socket (coax.)	X20637/96
SKTE	Start Input socket (coax.)	X50508/4
SKTF	Stop Input socket (coax.)	X50508/4
Terminal		
TP1	Chassis-earth terminal	Y51121
Inductors:		
L1, 2	Mains Choke	Y51159**
Neon Lamps:		
V (1-3)	Decimal Point Lamp 16L	Z50398
Crystal Oven:		
Oven (with socket)		Z50700
Fuse:	Rating	
FS1	500 mA	Z22867/2
Crystal:	Frequency	
XL1	2 MHz	Y20650/11
For Counters with type number suffix Z:-		
Data Logging Output Socket (36 pin)		X20637/80*

Ref:- P2136:7/1C/2-/3A/4C/5A/6-/7B.

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* Mating free plug:- Amphenol 57-30360; Venner Part No. X20637/79

** The two chokes are supplied as a pair under this part number.

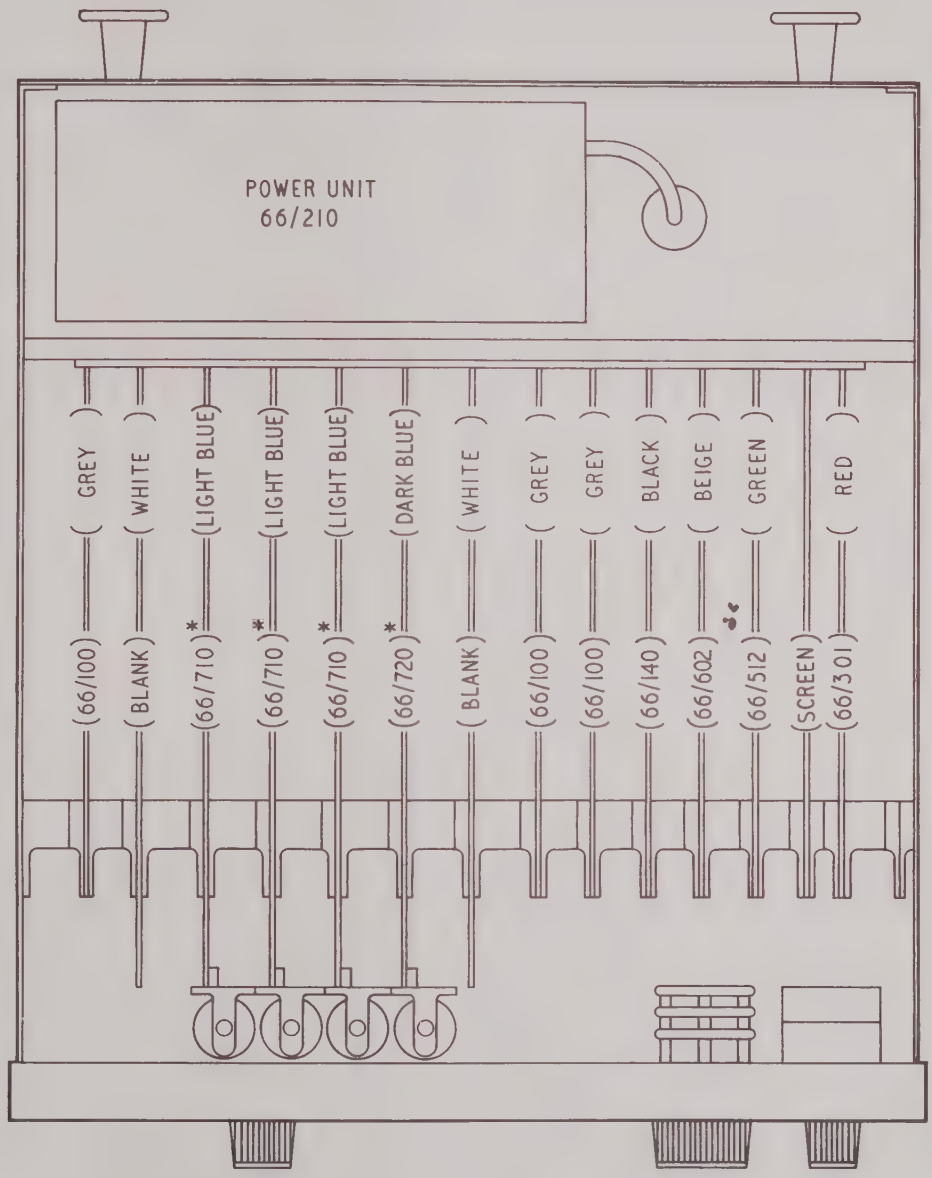
Note: The instrument may be supplied fitted with the above or equivalent types of components.

BOARD LAYOUT DIAGRAMS

Illustrations showing component and copper layout of plug-in printed circuit boards are provided amongst the following diagrams.

Each board is illustrated as viewed from the copper-side remote from the components; component positions are superimposed (as though the board were transparent).

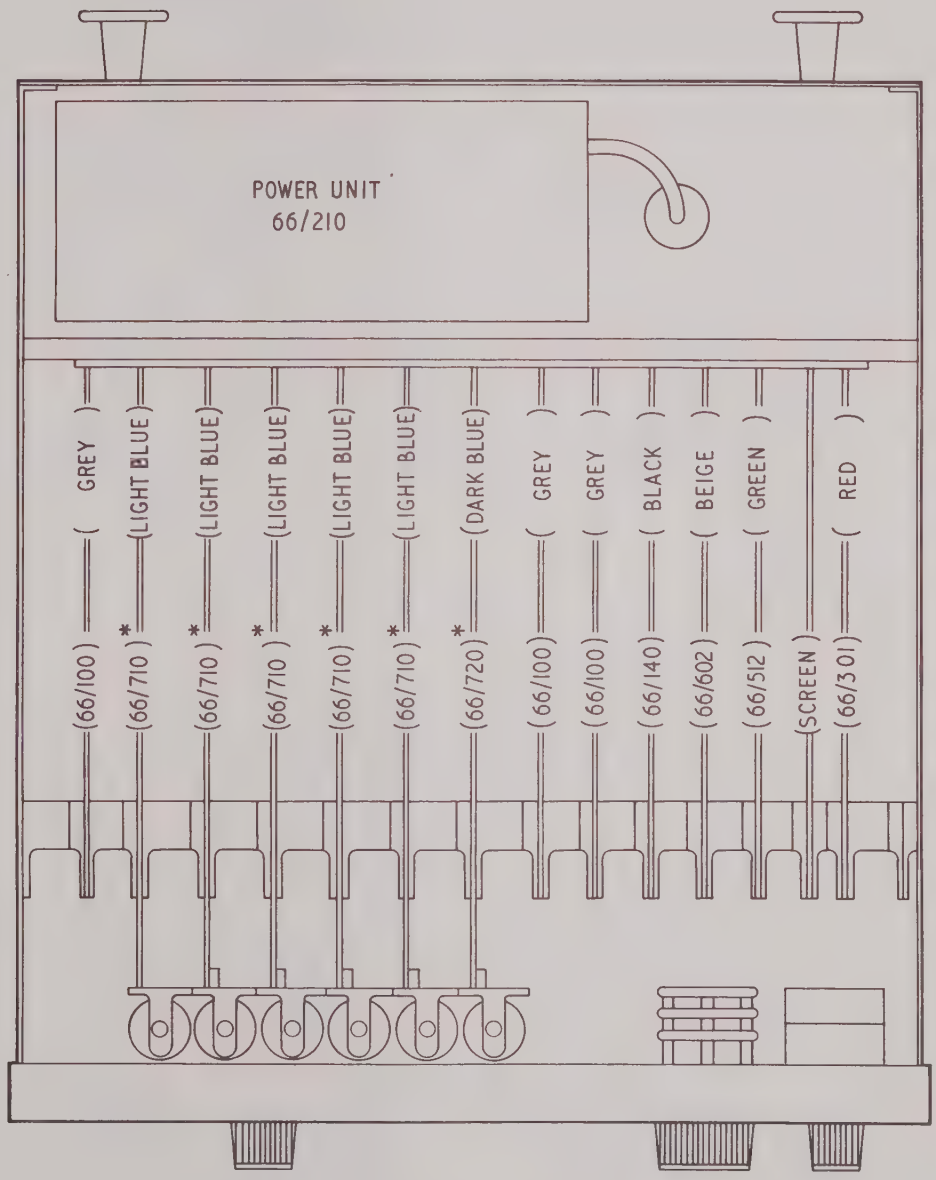
Some boards are also copper clad on the component-side; for these a further illustration (below the first) shows the board as viewed from the component-side but void of components.



*FOR COUNTERS WITH SUFFIX 'M':–
FOR 66/710 READ 66/710M
" 66/720 " 66/730

GENERAL LAYOUT OF COUNTER

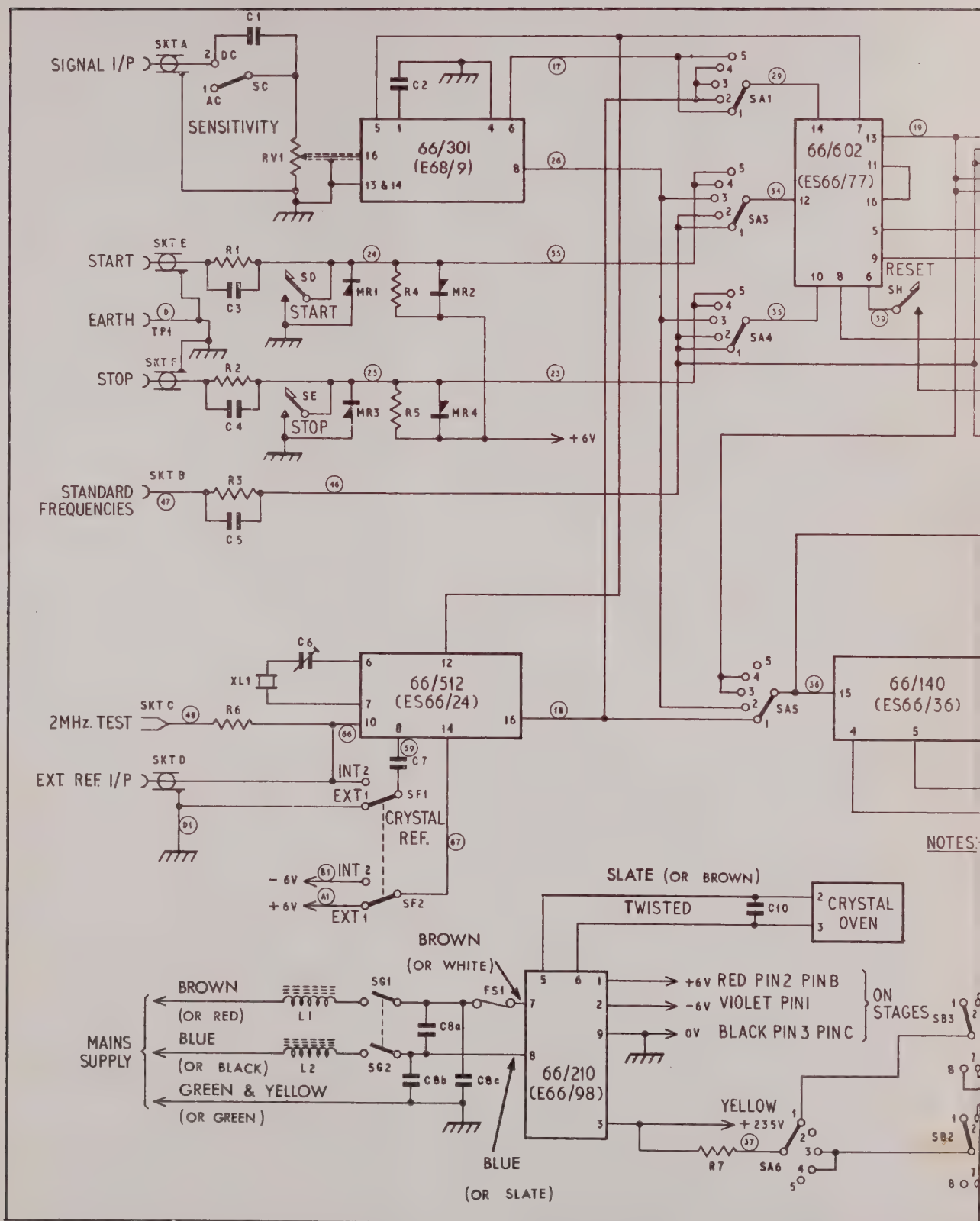
TYPE TSA6634A/2
DRG. NO S66/46

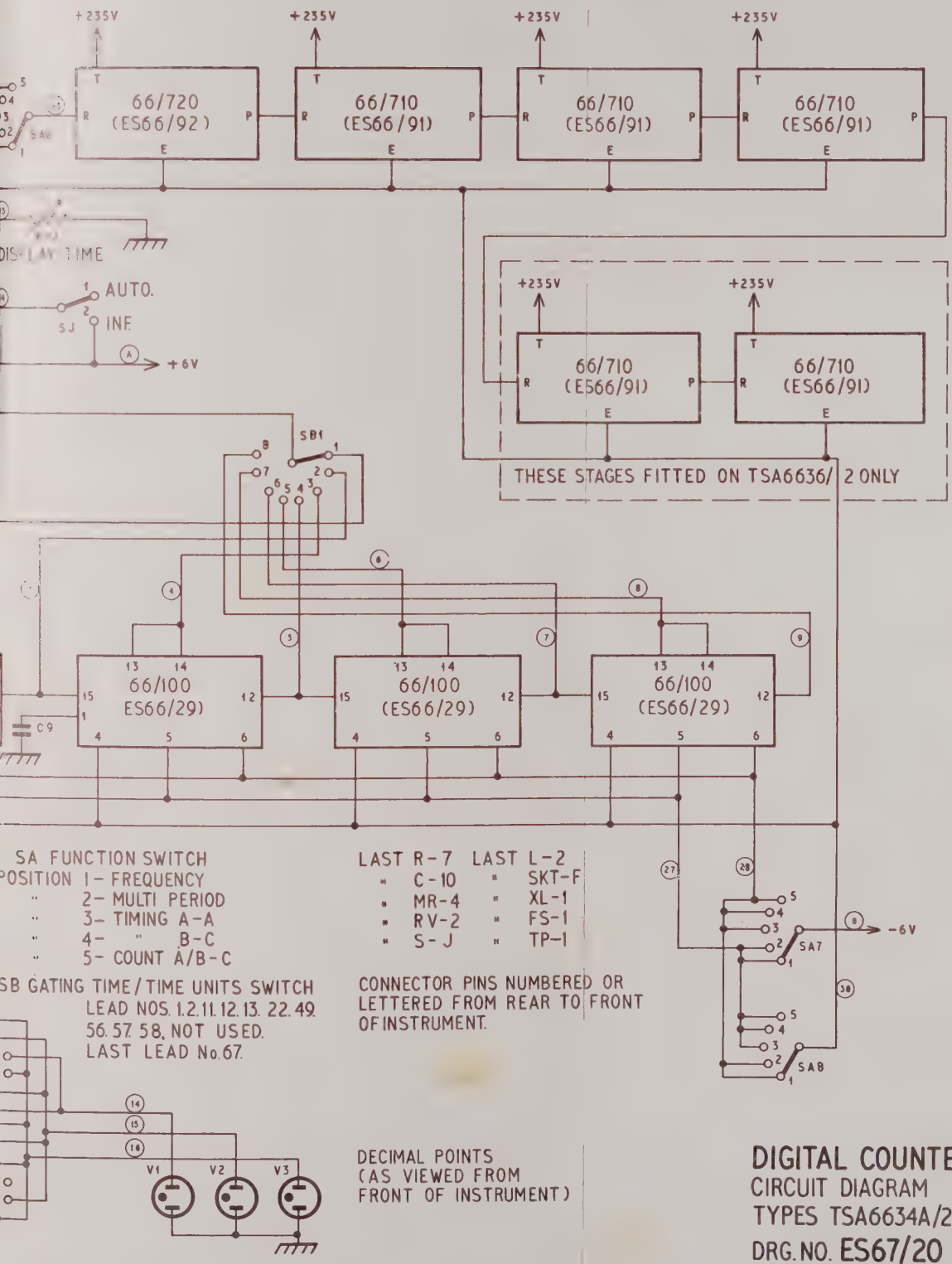


*FOR COUNTERS WITH SUFFIX 'M':–
FOR 66/710 READ 66/710M
" 66/720 " 66/730

GENERAL LAYOUT OF COUNTER

TYPE TSA6636/2
DRG.NO S66/47


SIGNAL I/P
SKT A
C1
DC
AC
SC
SENSITIVITY
RV1
C2
66/301
(E68/9)
SA1
66/602
(ES66/77)
SA3
SA4
RESET
SH
START
SKT E
R1
C3
SD
START
MR1
R4
MR2
EARTH
TP1
STOP
SKT F
R2
C4
SE
STOP
MR3
R5
MR4
+6V
STANDARD
FREQUENCIES
SKT B
R3
C5
C6
XL1
66/512
(ES66/24)
SA5
66/140
(ES66/36)
2MHz. TEST
SKT C
R6
EXT. REF. I/P
SKT D
INT 2
EXT 1
SF1
C7
CRYSTAL
REF.
-6V
+6V
SF2
SLATE (OR BROWN)
TWISTED
C10
CRYSTAL
OVEN
BROWN
(OR WHITE)
MAINS
SUPPLY
BROWN
(OR RED)
L1
BLUE
(OR BLACK)
L2
GREEN & YELLOW
(OR GREEN)
SG1
SG2
FS1
C8a
C8b
C8c
66/210
(E66/98)
+6V RED PIN 2 PIN B
-6V VIOLET PIN 1
0V BLACK PIN 3 PIN C
ON
STAGES
SB3
SB2
YELLOW
+235V
R7
SA6
BLUE
(OR SLATE)
NOTES:



SA FUNCTION SWITCH
POSITION 1 - FREQUENCY
" 2 - MULTI PERIOD
" 3 - TIMING A-A
" 4 - " B-C
" 5 - COUNT A/B-C

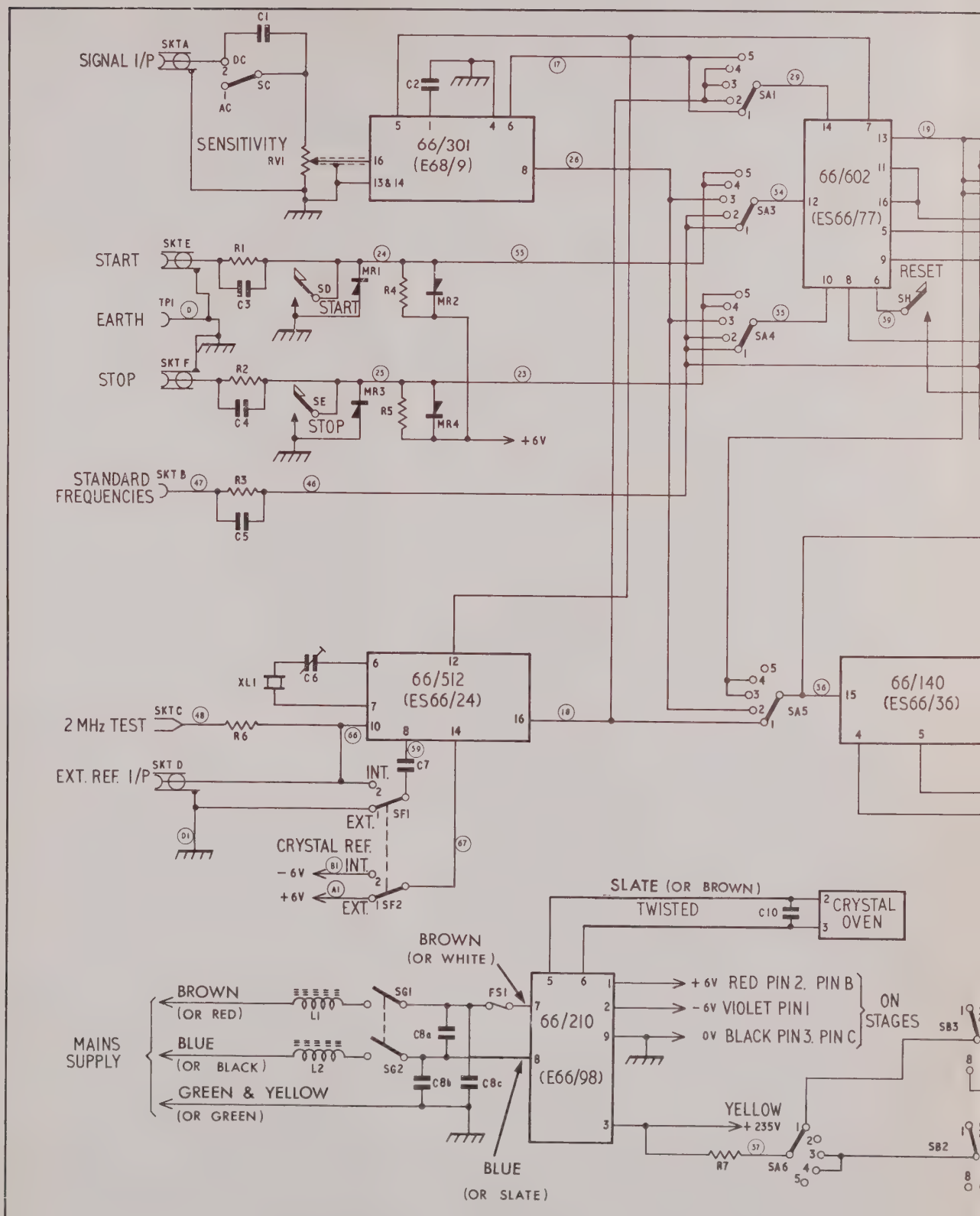
SB GATING TIME / TIME UNITS SWITCH
LEAD NOS. 1.2.11.12.13. 22.49. 56.57.58, NOT USED.
LAST LEAD No.67.

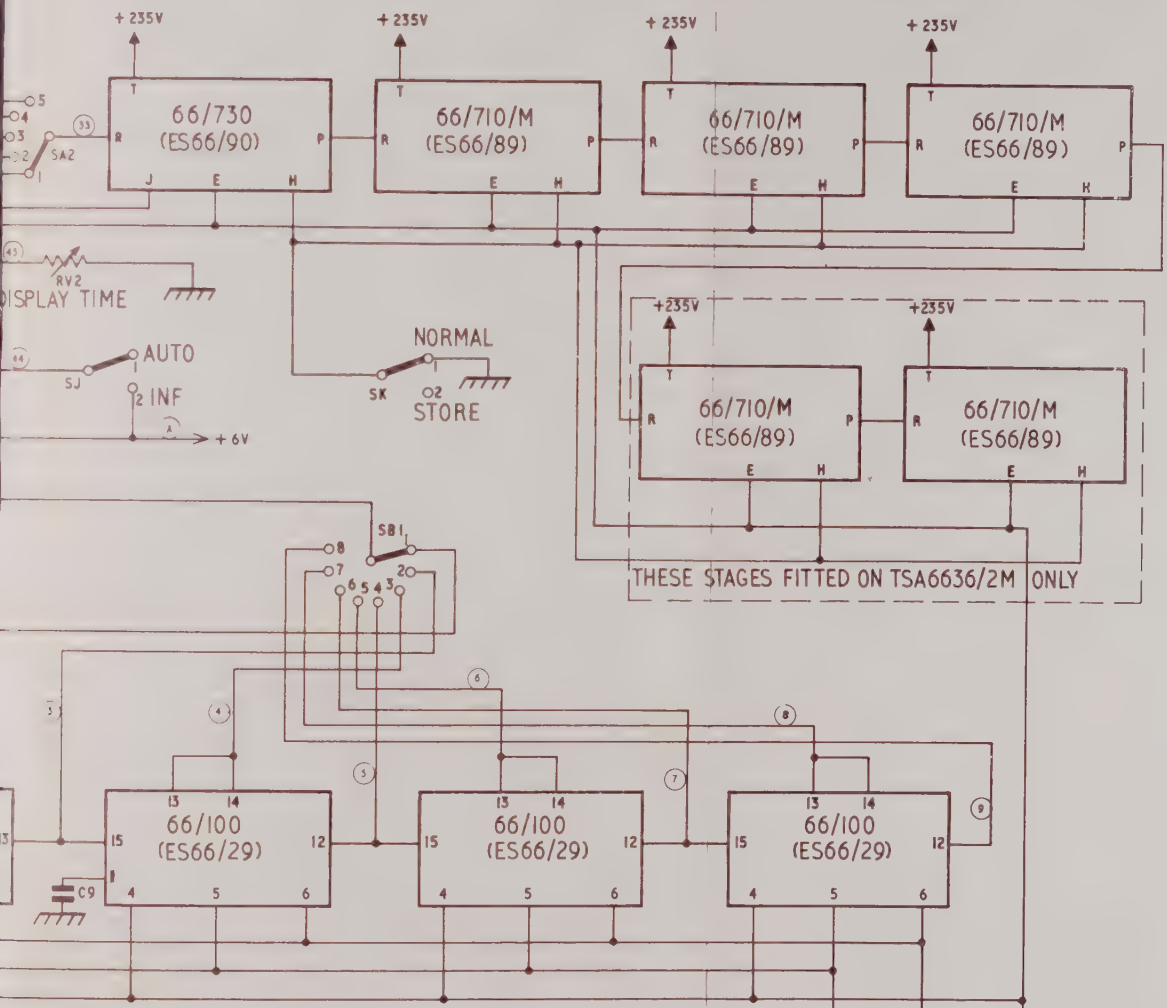
LAST R-7	LAST L-2
" C-10	" SKT-F
" MR-4	" XL-1
" RV-2	" FS-1
" S-J	" TP-1

CONNECTOR PINS NUMBERED OR LETTERED FROM REAR TO FRONT OF INSTRUMENT.

DECIMAL POINTS
(AS VIEWED FROM
FRONT OF INSTRUMENT)

DIGITAL COUNTER
CIRCUIT DIAGRAM
TYPES TSA6634A/2 & TSA6636/2
DRG. NO. ES67/20 ISSUE B


SIGNAL I/P
SKT A
C1
DC
SC
AC
SENSITIVITY
RV1
C2
66/301
(E68/9)
SA1
66/602
(ES66/77)
SA3
SA4
RESET
SH
START
SKT E
R1
C3
SD
START
MR1
R4
MR2
EARTH
TP1
STOP
SKT F
R2
C4
SE
STOP
MR3
R5
MR4
+6V
STANDARD FREQUENCIES
SKT B
R3
C5
XL1
C6
66/512
(ES66/24)
2 MHz TEST
SKT C
R6
EXT. REF. I/P
SKT D
INT.
EXT.
SF1
CRYSTAL REF.
-6V
+6V
SF2
SA5
66/140
(ES66/36)
SLATE (OR BROWN)
TWISTED
C10
CRYSTAL OVEN
BROWN
(OR WHITE)
MAINS SUPPLY
BROWN
(OR RED)
L1
SG1
FS1
BLUE
(OR BLACK)
L2
SG2
GREEN & YELLOW
(OR GREEN)
C8a
C8b
C8c
66/210
(E66/98)
+6V RED PIN 2. PIN B
-6V VIOLET PIN 1
0V BLACK PIN 3. PIN C
ON STAGES
SB3
YELLOW
+235V
R7
SA6
SB2
BLUE
(OR SLATE)

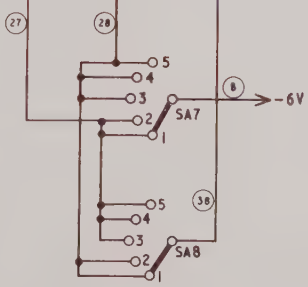


OTES

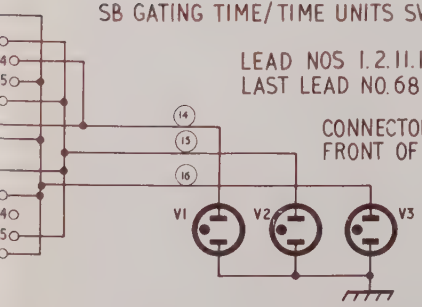
SA FUNCTION SWITCH
POSITION 1-FREQUENCY
" 2-MULTI PERIOD
" 3-TIMING A-A
" 4- " B-C
" 5-COUNT A/B-C

SB GATING TIME/TIME UNITS SWITCH

LAST R-7 LAST L-2
" C-10 " TP-1
" MR-4
" RV-2
" S-K
" SKT-F
" XL-1
" FS-1



LEAD NOS 1.2.11.12.13.22.49.56.57.58. NOT USED.
LAST LEAD NO.68



CONNECTOR PINS NUMBERED OR LETTERED FROM REAR TO FRONT OF INSTRUMENT.

DECIMAL POINTS
(AS VIEWED FROM FRONT OF INSTRUMENT)

DIGITAL COUNTER
CIRCUIT DIAGRAM
TYPES TSA6634A/2M & TSA6636/2M
DRG. NO. ES67/21 ISSUE B

POSITION	FUNCTION	
1	FREQUENCY	S (
2	MULTI–PERIOD	
3	TIMING A–A	
4	TIMING B–C	
5	COUNT $\frac{A}{B-C}$	S (

RANGE SWITCH (WA

POSITON	FREQUENCY AT
1	AS AT SA5 ROT
2	" " "
3	" " "
4	" " "
5	" " "
6	" " "
7	" " "
8	" " "

FUNCTION SELECTOR (SWITCH SA)

ROTORS

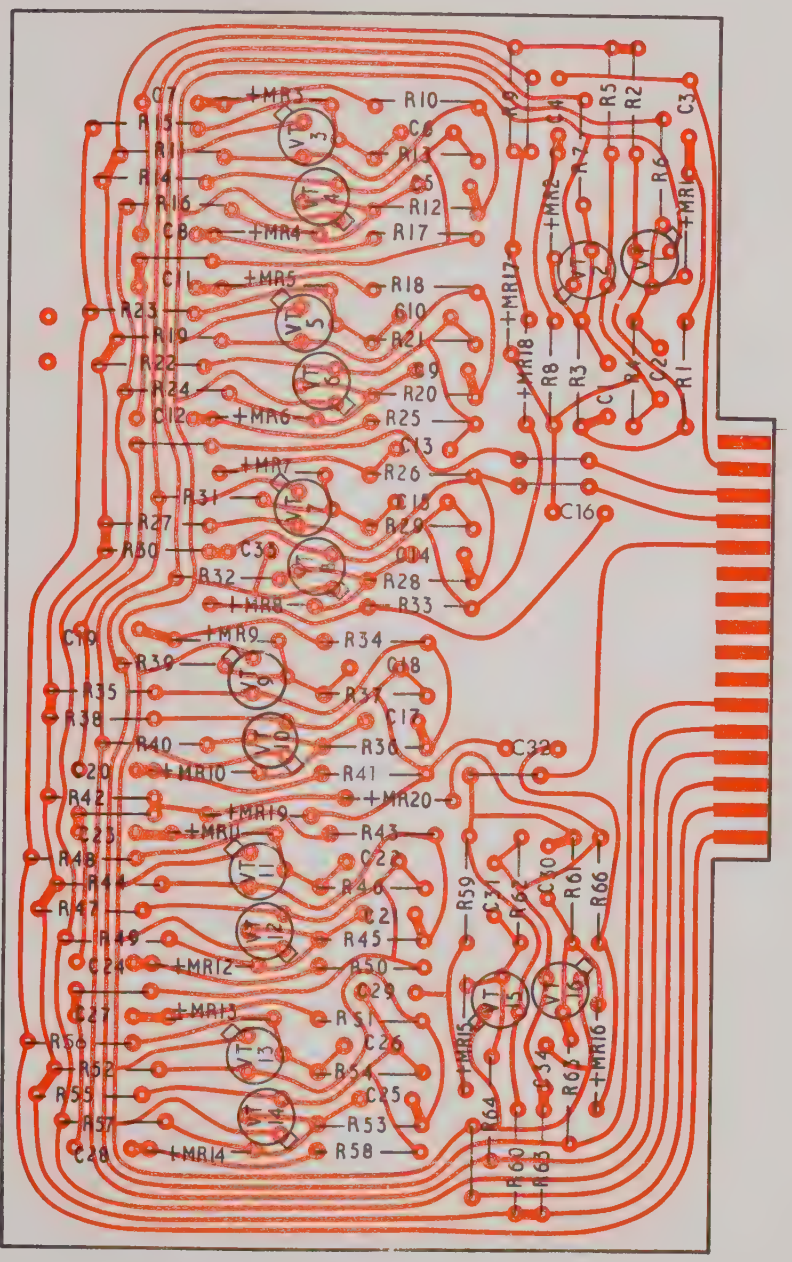
SA1 (GATE INPUT)	SA2 (COUNTER CHAIN INPUT)	SA3 ('START' GATE-CONTROL)	SA4 ('STOP' GATE-CONTROL)	SA5 (FREQ. DIVIDER INPUT)	SA6 (DECI. POINT ROUTING)	SA7 (FREQ. DIVIDER SUPPLY)	SA8 (FREQ. DIVIDER RESET)
SHAPED -INPUT SIGNALS SITIVE PULSES)	GATE OUTPUT	1st NEGATIVE PULSE VIA SB1 ROTOR * OPENS GATE	2nd NEGATIVE PULSE VIA SB1 ROTOR * CLOSES GATE	1 MHz OUTPUT OF OSCILLATOR STAGE	APPLIES DECIMAL POINT SUPPLY TO SB3 ROTOR	HOLDS UNUSED RESET LINE (TP5) OF FREQUENCY DIVIDER STAGES AT −6V	APPLIES MAIN RESET LINE TO TP6 OF FREQUENCY DIVIDER STAGES (WHICH ARE RESET TO '9')
1 MHz OUTPUT OF ILLATOR STAGE	"	"	"	SHAPED SKTA-INPUT SIGNALS (NEGATIVE PULSES)	UNUSED	"	"
"	PULSE TRAIN SELECTED BY SB1 ROTOR *	1st NEGATIVE PULSE FROM SKTA-INPUT SHAPER OPENS GATE	2nd NEGATIVE PULSE FROM SKTA-INPUT SHAPER CLOSES GATE	GATE OUTPUT	APPLIES DECIMAL POINT SUPPLY TO SB2 ROTOR	HOLDS UNUSED RESET LINE (TP6) OF FREQUENCY DIVIDER STAGES AT −6V	APPLIES MAIN RESET LINE TO TP5 OF FREQUENCY DIVIDER STAGES (WHICH ARE RESET TO '0')
"	"	START SIGNAL AT SKTE (OR DEPRESSION OF SD) OPENS GATE	STOP SIGNAL AT SKTF (OR DEPRESSION OF SE) CLOSES GATE	"	"	"	"
SHAPED -INPUT SIGNALS SITIVE PULSES)	GATE OUTPUT	"	"	UNUSED	UNUSED	"	"

* SEE CHART ON LEFT.

ER SB1)
TOR
R (1MHz ON FREQUENCY FUNCTION)
10 (100 kHz ON FREQUENCY FUNCTION)
10^2 (10 kHz ON FREQUENCY FUNCTION)
10^3 (1 kHz ON FREQUENCY FUNCTION)
10^4 (100Hz ON FREQUENCY FUNCTION)
10^5 (10Hz ON FREQUENCY FUNCTION)
10^6 (1 Hz ON FREQUENCY FUNCTION)
10^7 (0·1 Hz ON FREQUENCY FUNCTION)

SIGNAL FLOW / FUNCTION CHART

DRG. NO. S65/22

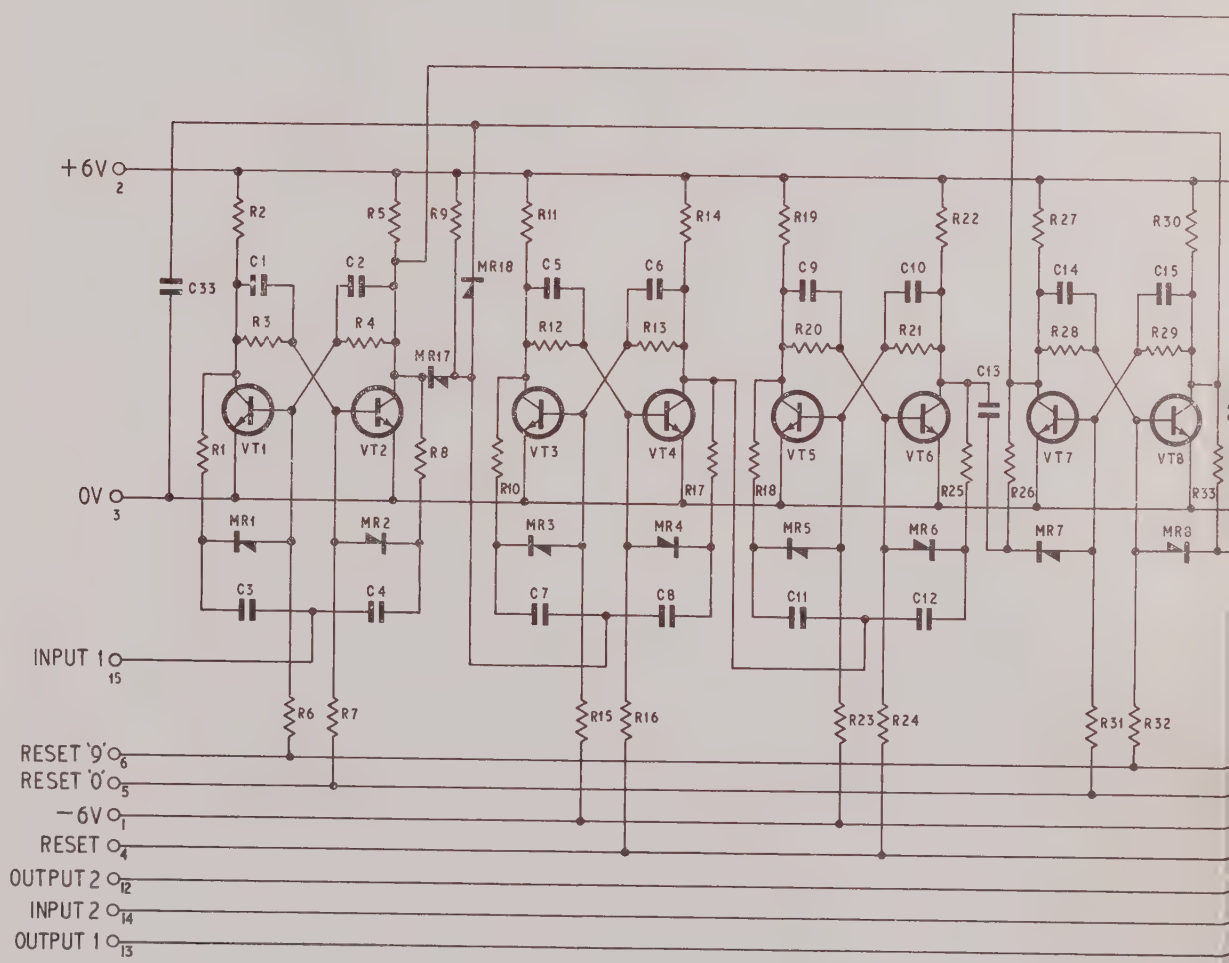


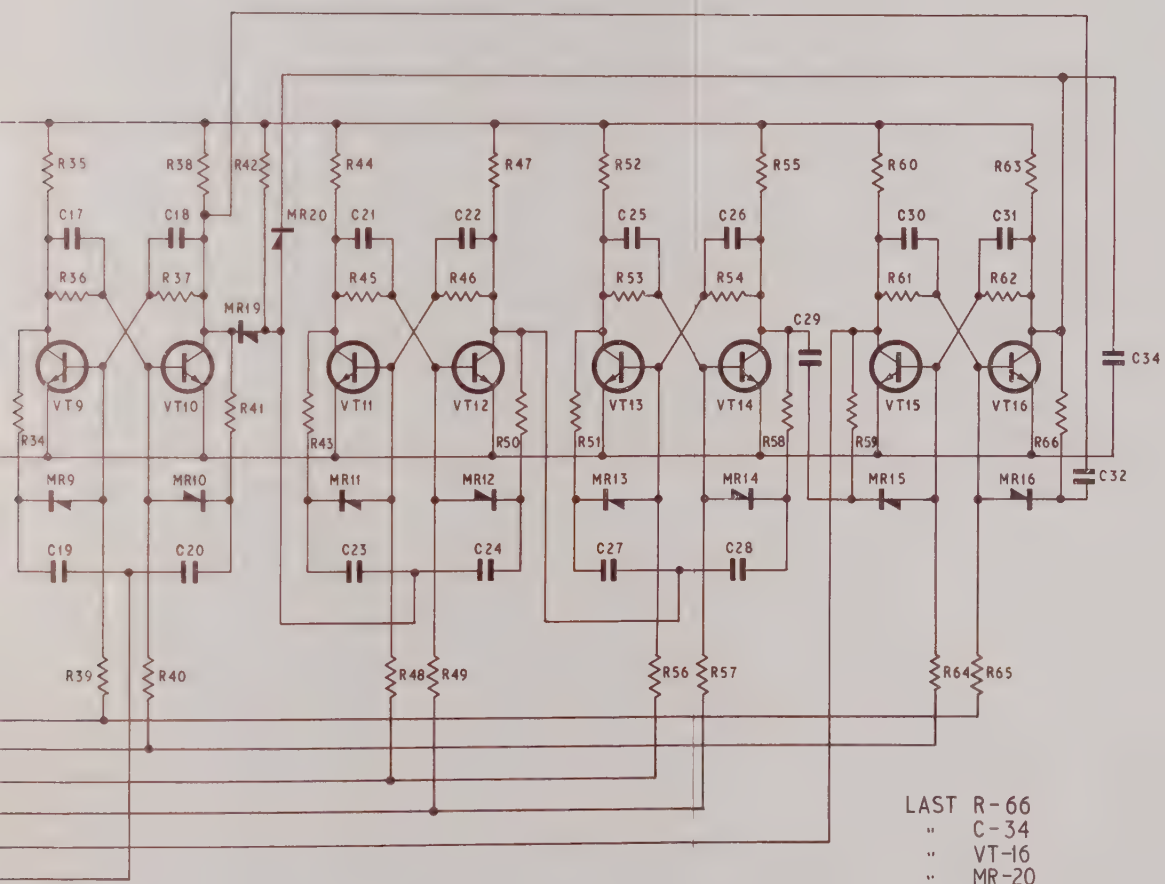
VIEWED FROM COPPER SIDE

REF: M2067A
M2068A

DOUBLE DECADE TYPE 66/100

BL 66/100


+6V
2
0V
3
INPUT 1
15
RESET '9'
6
RESET '0'
5
−6V
1
RESET
4
OUTPUT 2
12
INPUT 2
14
OUTPUT 1
13
C33
C1
C2
C5
C6
C9
C10
C13
C14
C15
R1
R2
R3
R4
R5
R8
R9
R10
R11
R12
R13
R14
R17
R18
R19
R20
R21
R22
R25
R26
R27
R28
R29
R30
R33
MR1
MR2
MR3
MR4
MR5
MR6
MR7
MR8
MR17
MR18
VT1
VT2
VT3
VT4
VT5
VT6
VT7
VT8
C3
C4
C7
C8
C11
C12
R6
R7
R15
R16
R23
R24
R31
R32

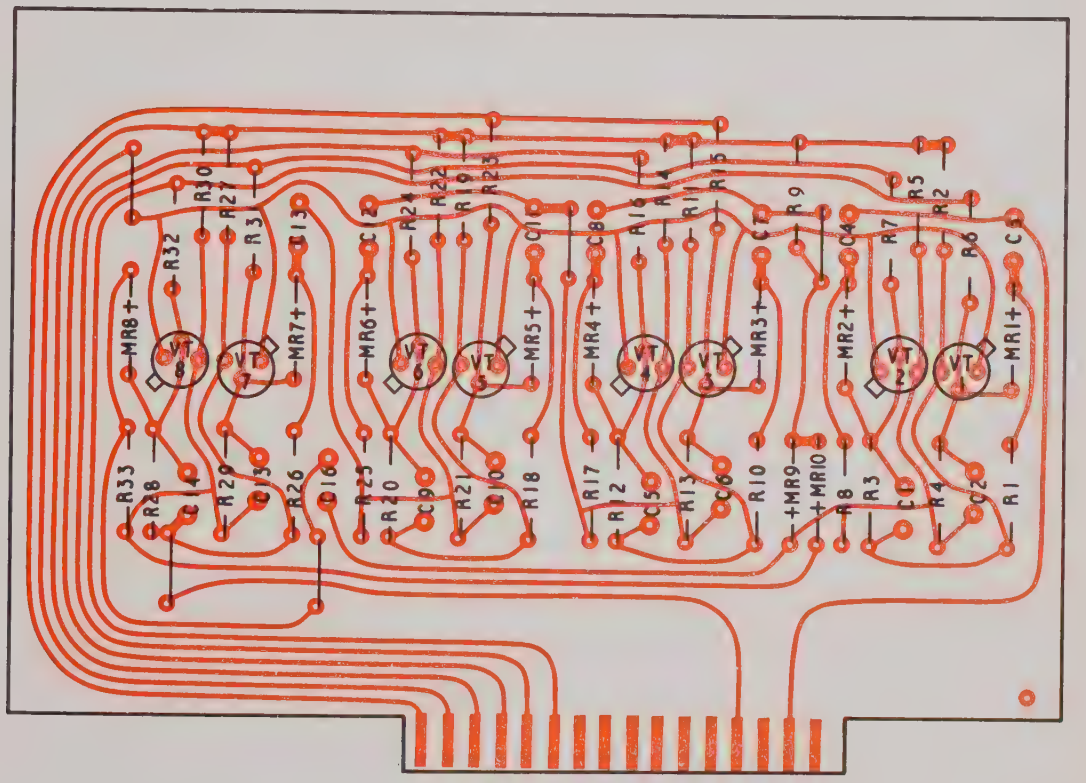


LAST R-66
" C-34
" VT-16
" MR-20

DOUBLE DECADE

TYPE 66/100

DRG.NO ES66/29 ISSUE A

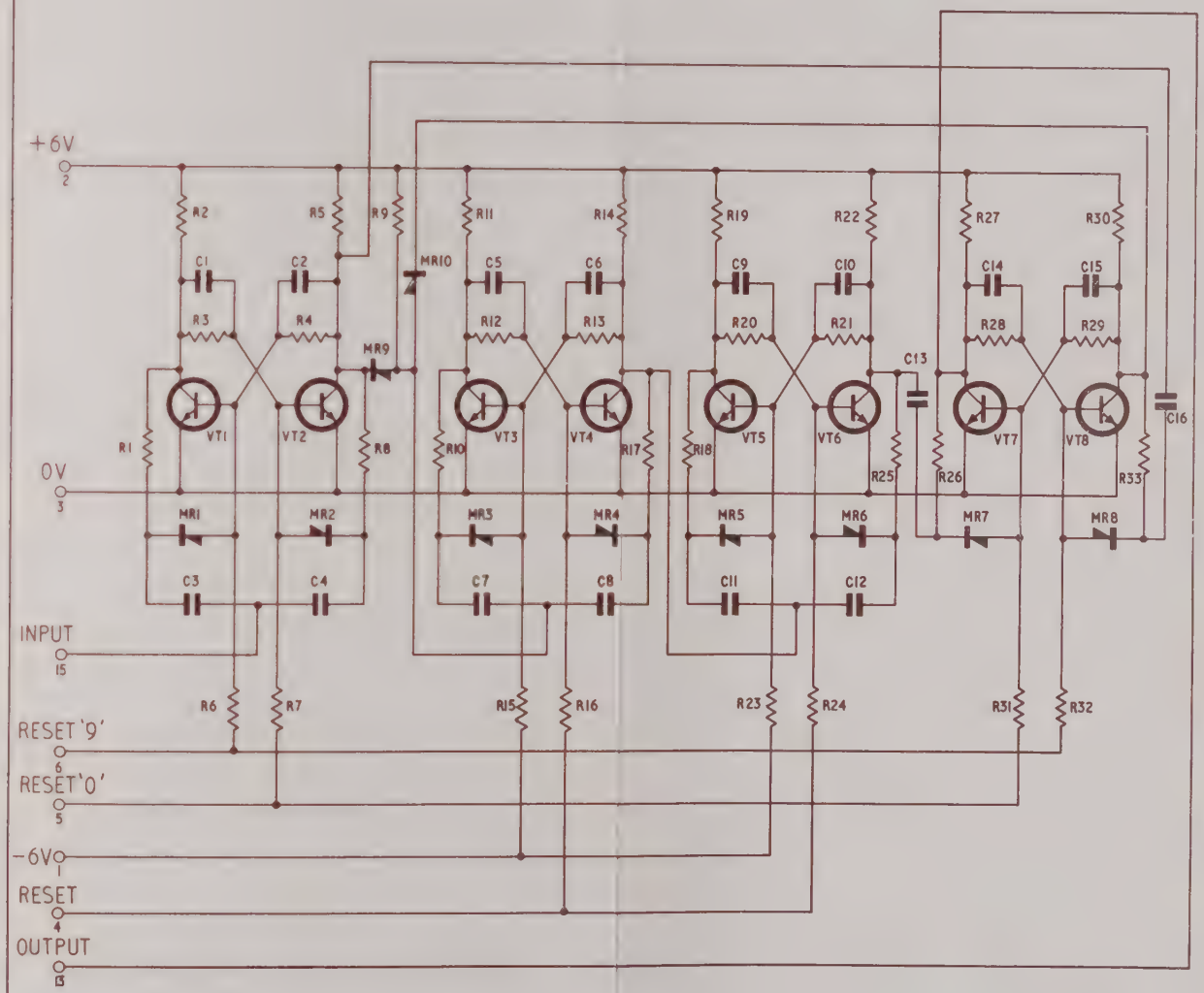


VIEWED FROM COPPER SIDE

REF: M 2134 A
M 2135 A

DECADE DIVIDER TYPE 66/140

BL 66/140

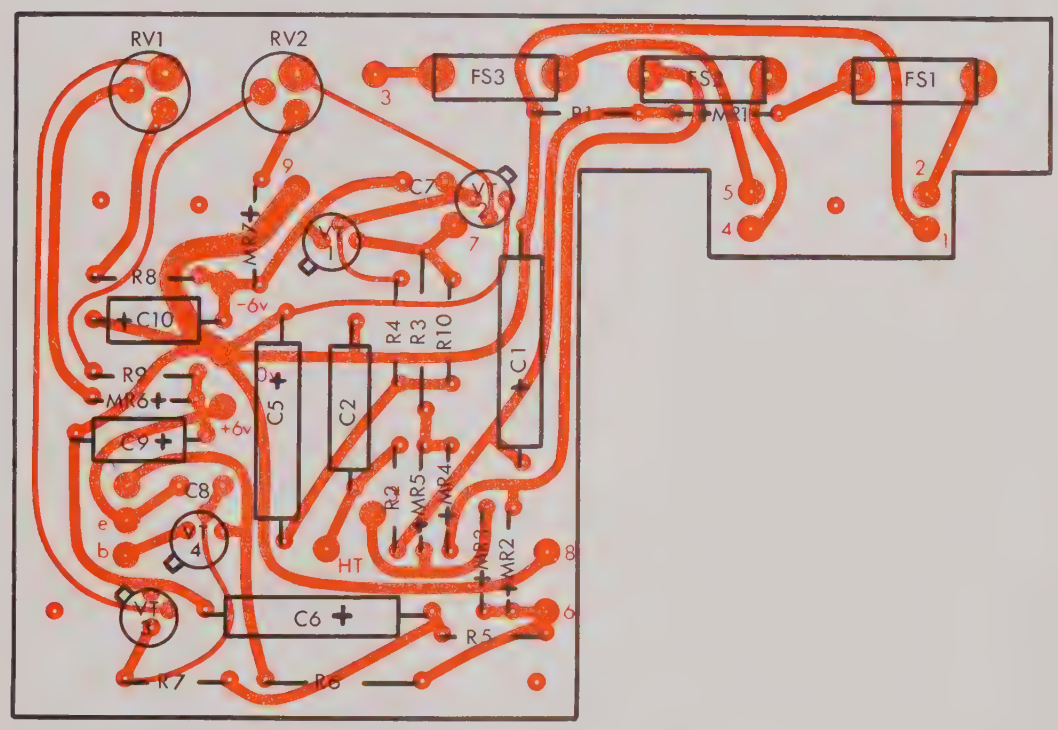


LAST R-33
" C-16
" VT-8
" MR-10

DECADE DIVIDER

TYPE 66/140

DRG. NO ES66/36

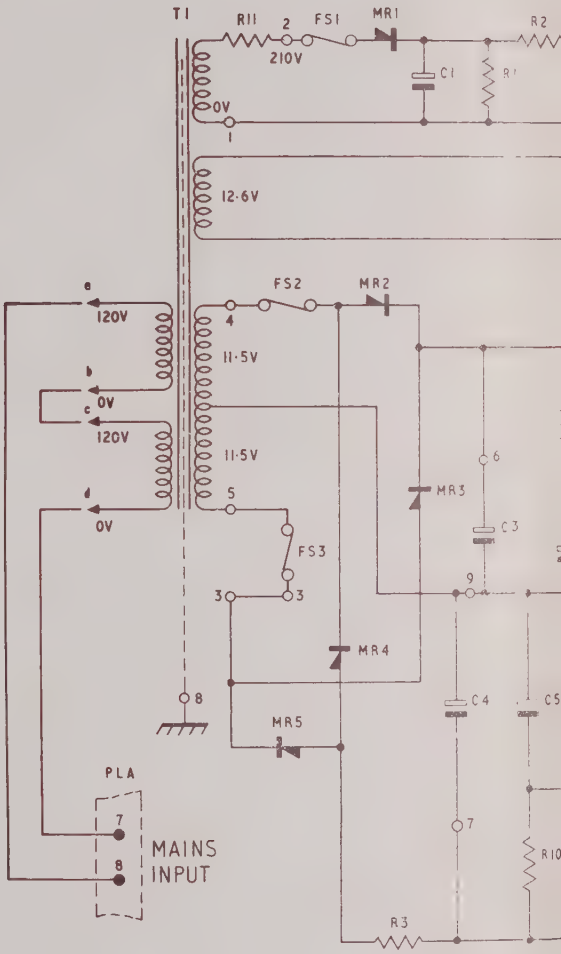


VIEWED FROM COPPER SIDE

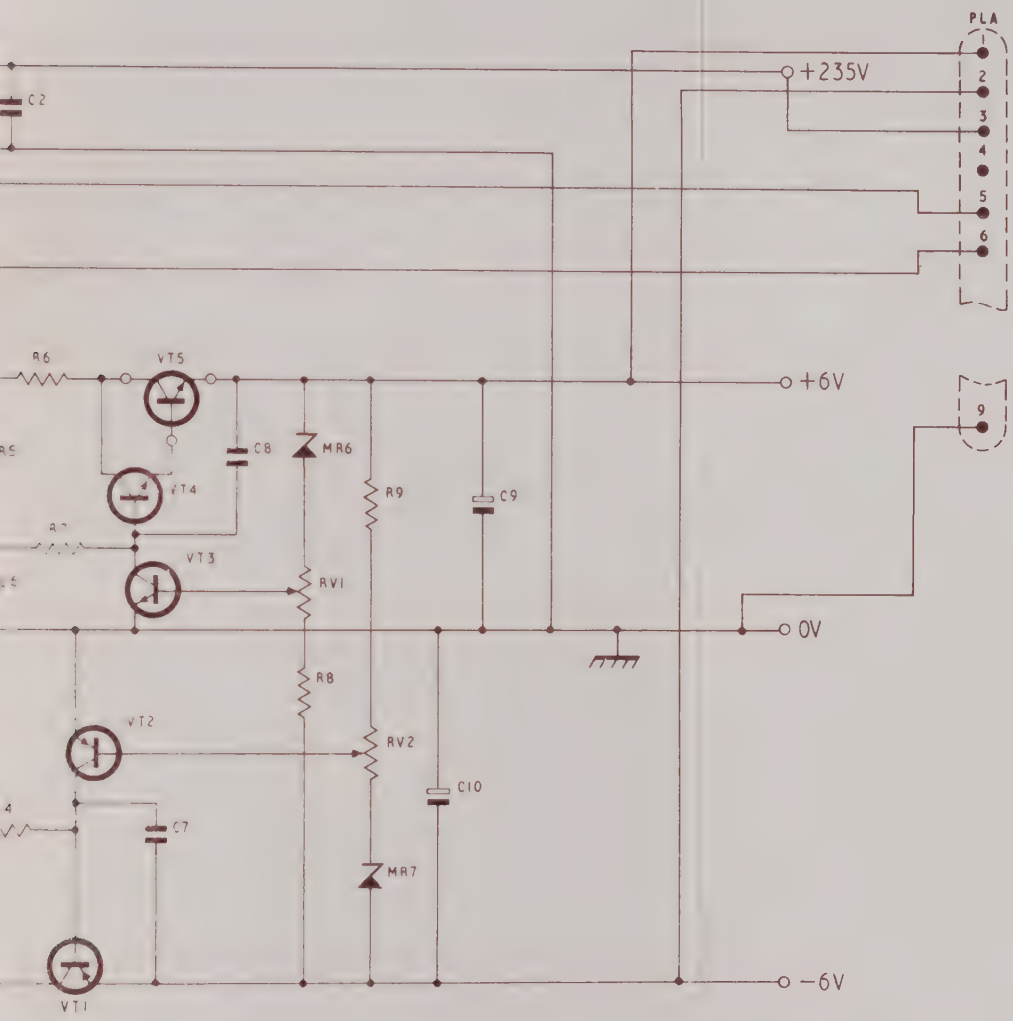
REF: M2261
M2260

POWER SUPPLY TYPE 66/210

BL66/210



LAST R-11
" RV-2
" C-10
" MR-7
" VT-5
" FS-3

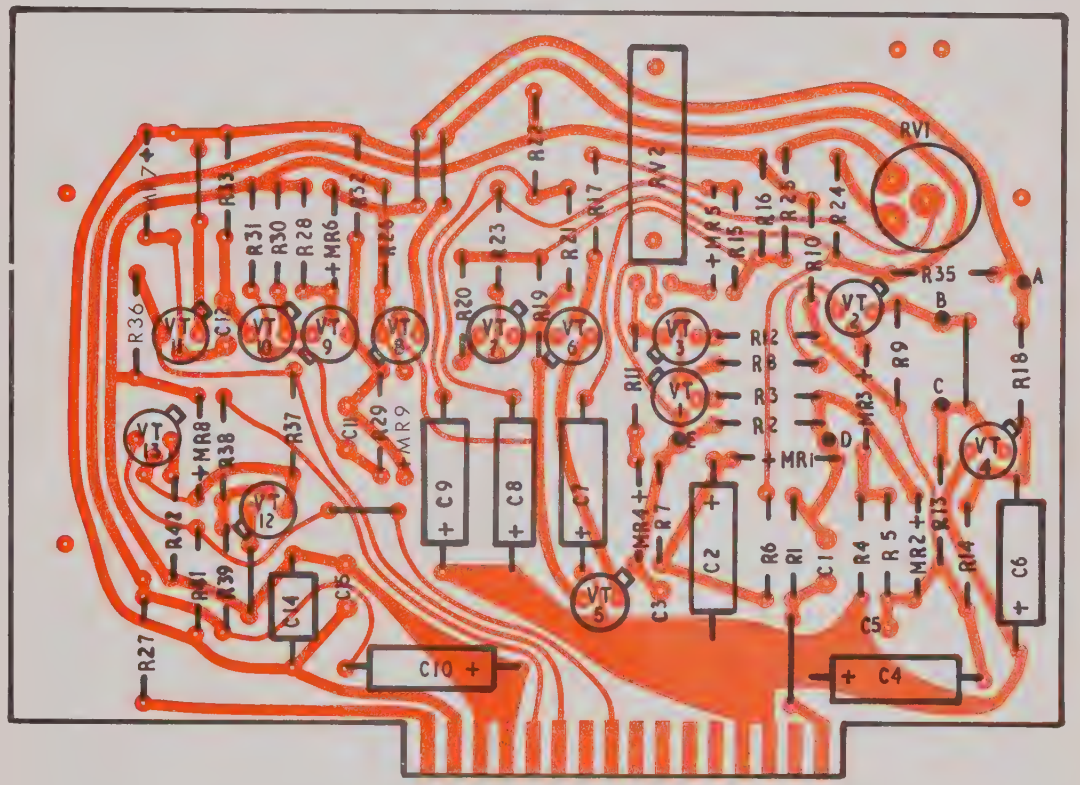


NOTES :- CONNECTIONS ARE SHOWN FOR 200/250V WORKING.
FOR 100/125V WORKING DISCONNECT LINK FROM b-c & CONNECT LINKS FROM a TO c AND b TO d.
TERMINATION POINTS ON THE PRINTED CIRCUIT BOARD ARE NUMBERED THUS —o 2

POWER SUPPLY

TYPE 66/210

DRG. NO. E66/98 ISSUE A



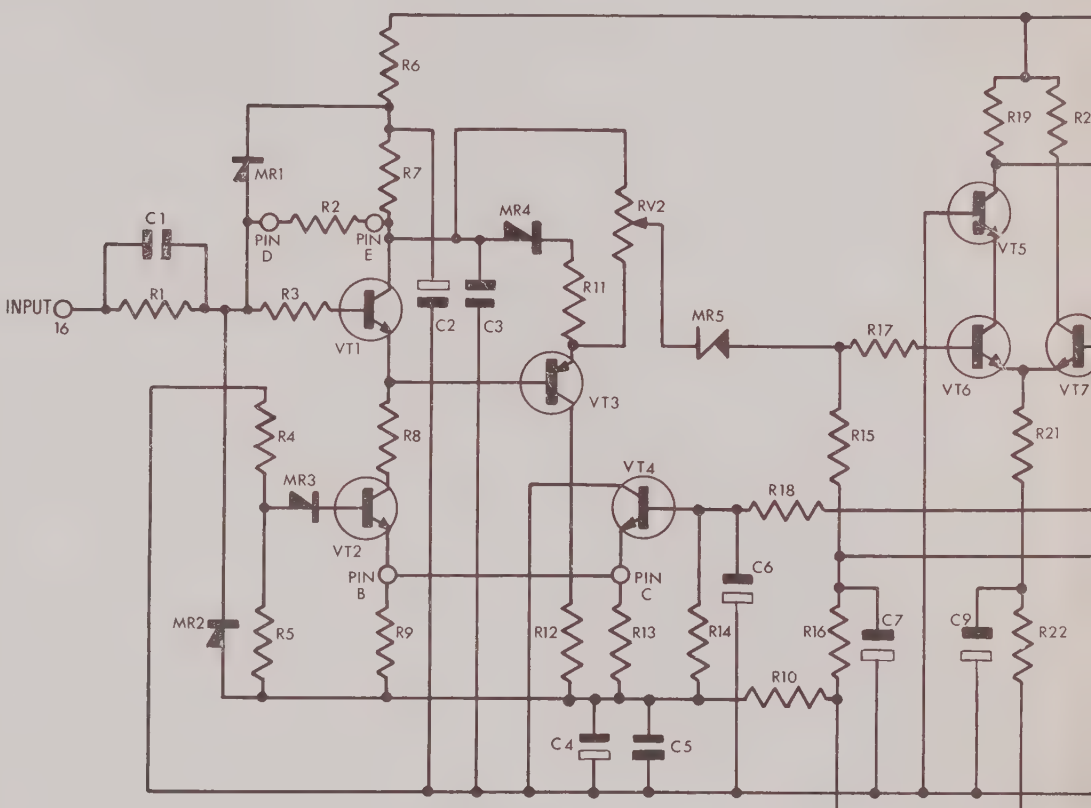
VIEWED FROM COPPER SIDE

TEST POINTS – A, B, C, D AND E.

REF: M2069/B
M2070/D

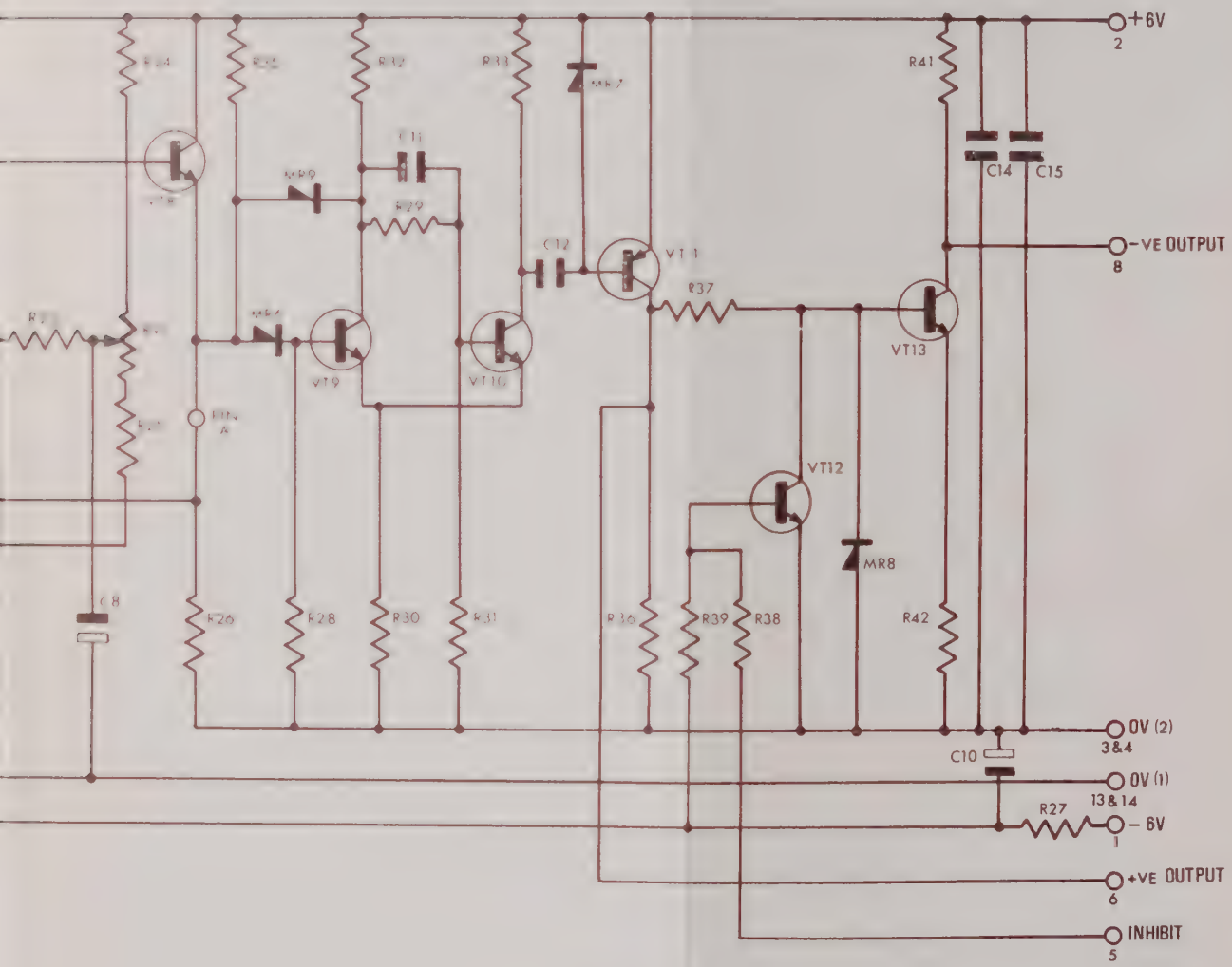
PULSE SHAPER TYPE 66/301

BL 66/301



LAST R – 42
" C – 15
" MR – 9
" VT – 13
" RV – 2

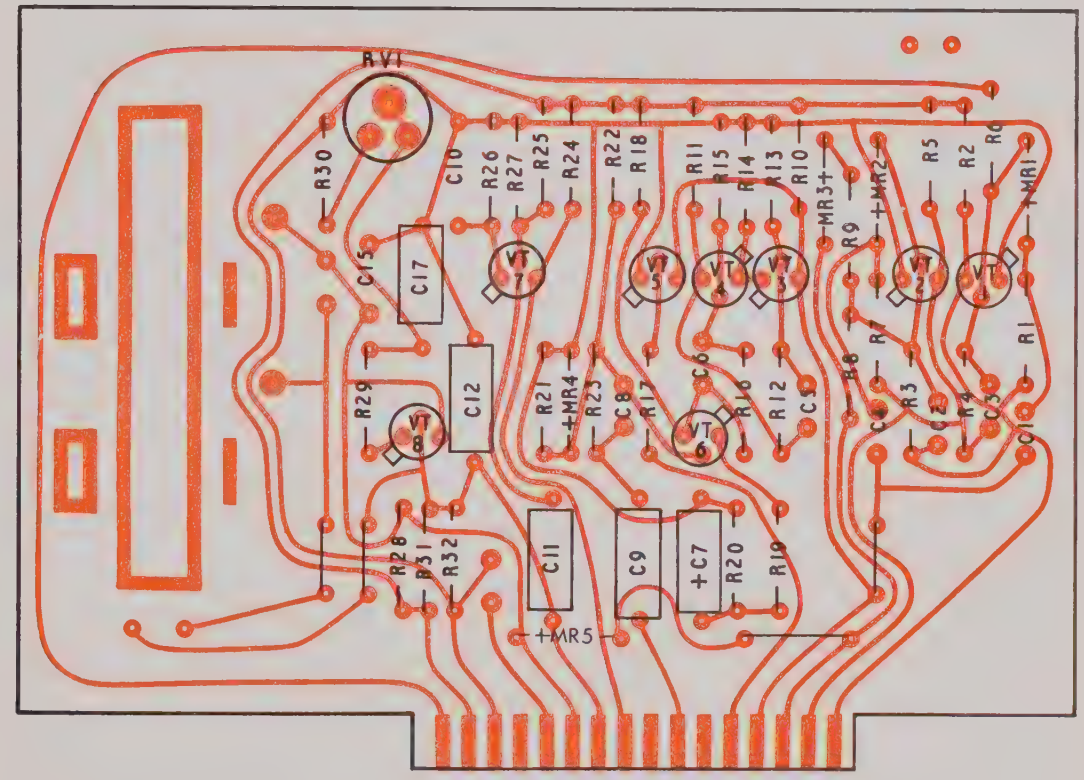
R34 NOT USED
R40 " "
C13 " "



PULSE SHAPER

TYPE 66/301

DRG. NO E68/9 ISSUE A

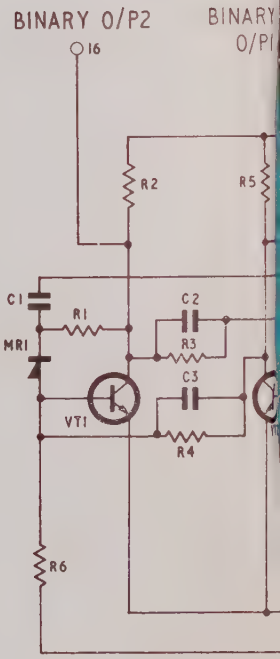


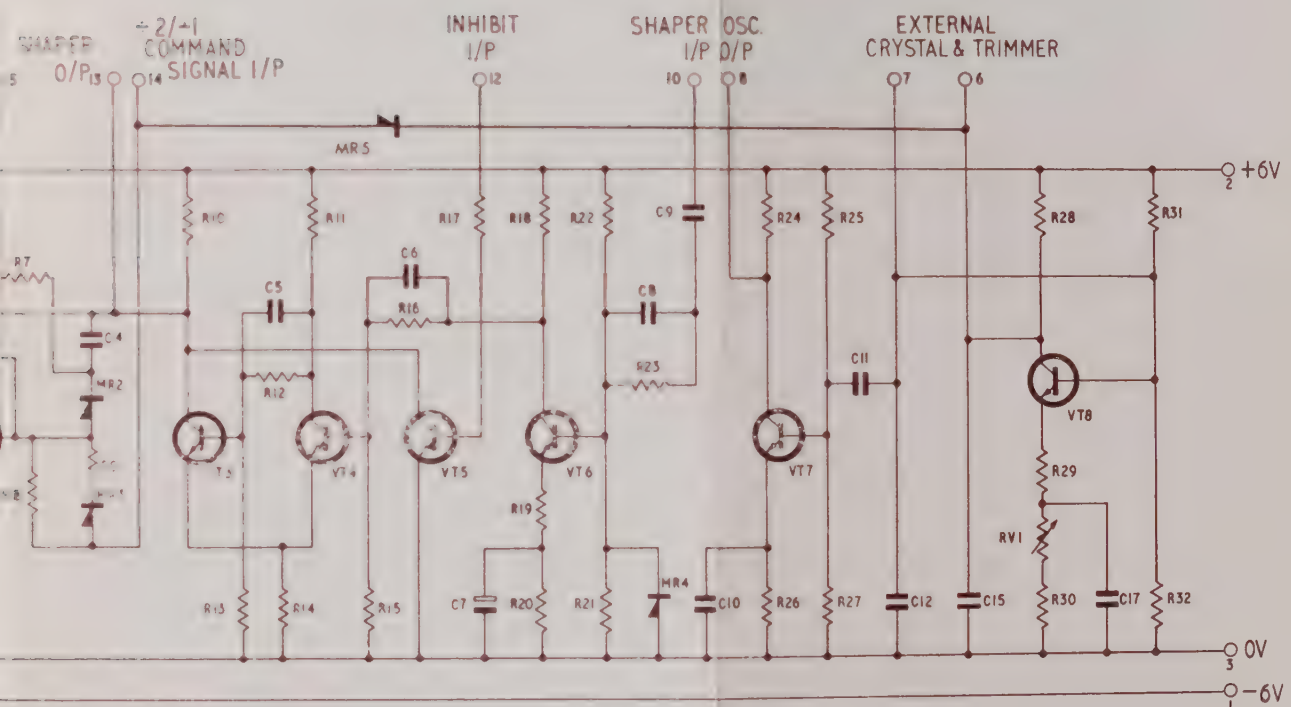
VIEWED FROM COPPER SIDE

REF:M 2071B
M 2156A

OSCILLATOR TYPE 66/512

BL66/512


BINARY O/P2
16
R2
R5
C1
R1
C2
R3
MR1
C3
VT1
R4
R6



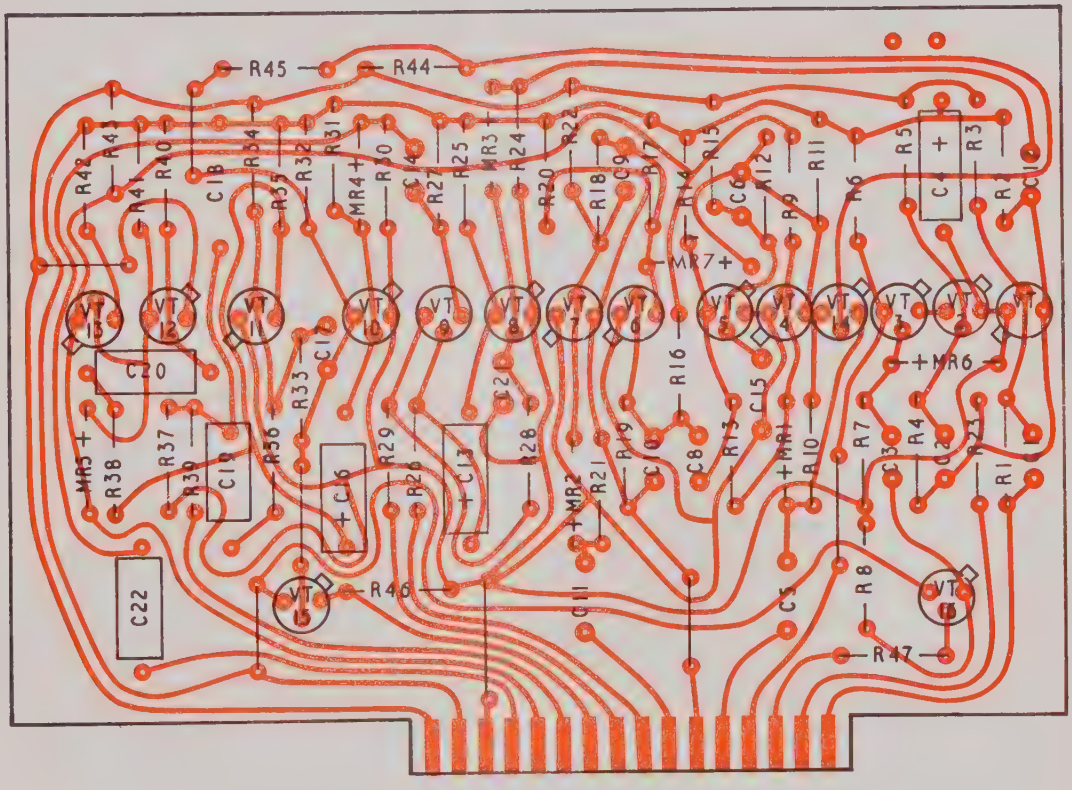
LAST R-32
" C-17
" MR-5
" VT-8
" RV-1

C13, 14, 16 NOT USED

OSCILLATOR

TYPE 66/512

DRG. NO. ES66/24 ISSUE B

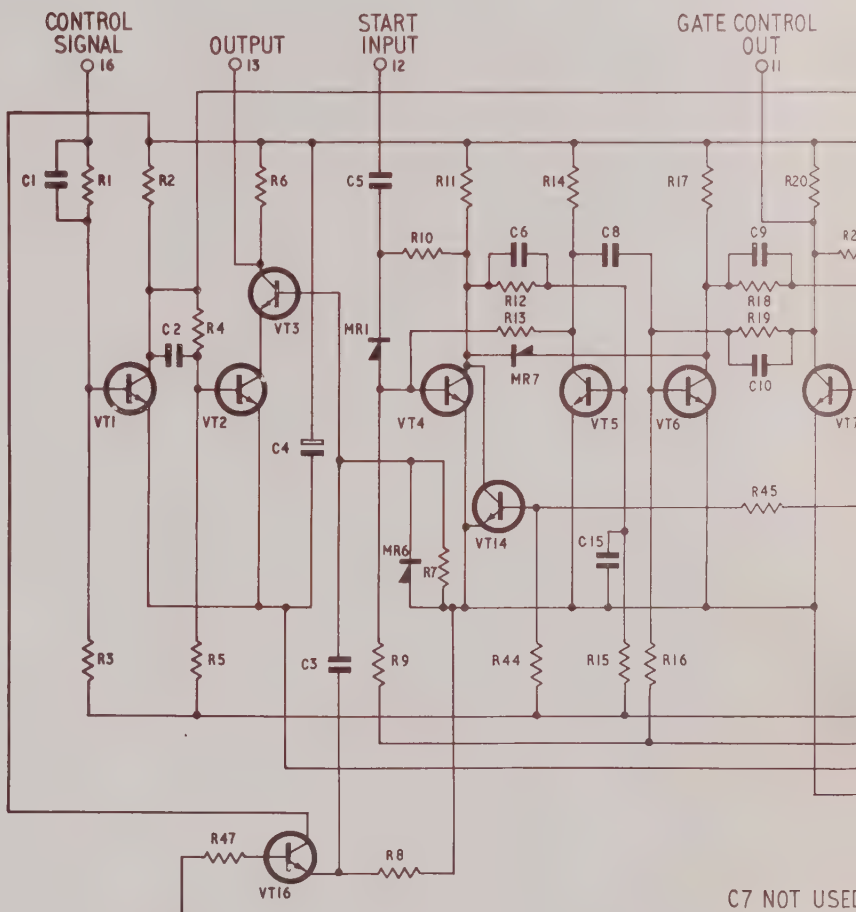


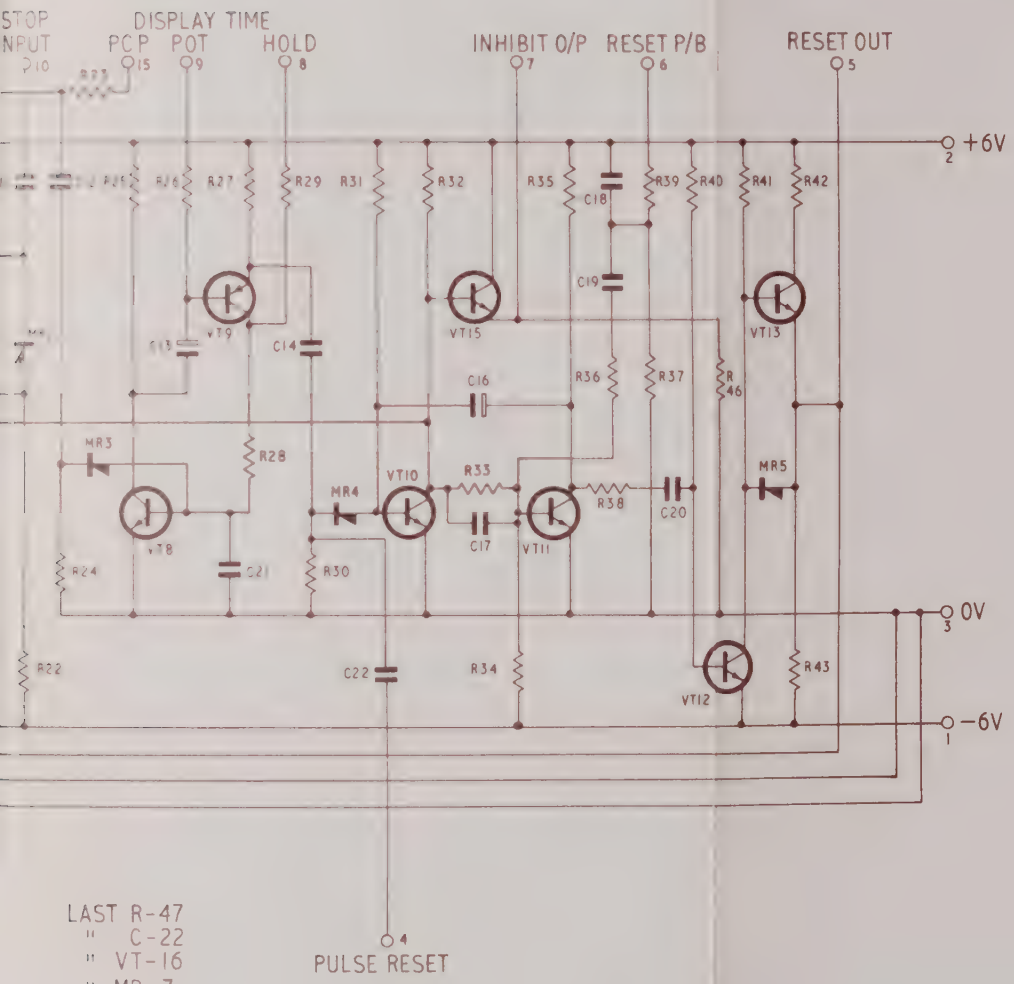
VIEWED FROM COPPER SIDE

REF: M 2192
M 2193

GATE CONTROL AND RESET TYPE 66/602

BL66/602

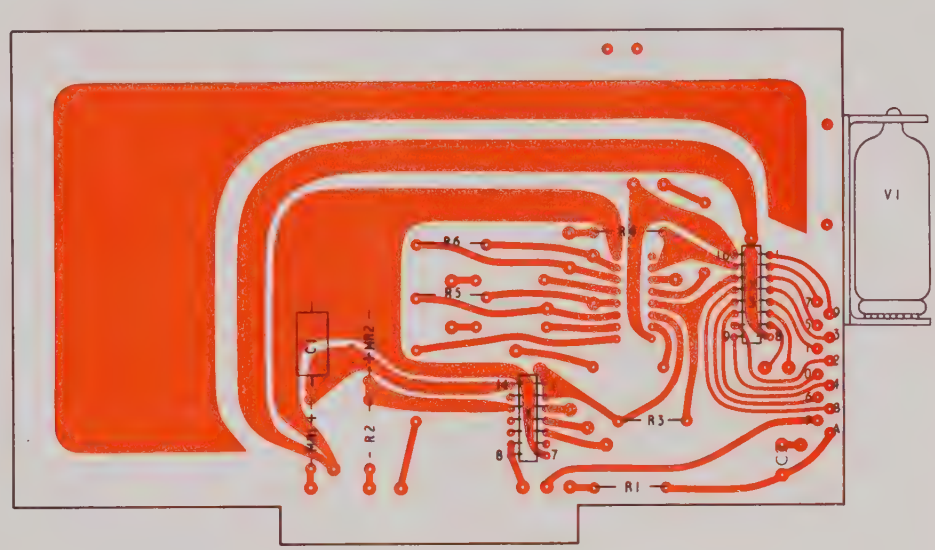

CONTROL SIGNAL
16
OUTPUT
13
START INPUT
12
GATE CONTROL OUT
11
C1
R1
R2
R6
C5
R11
R14
R17
R20
R10
C6
C8
C9
R12
R18
R13
R19
C2
R4
VT3
MR1
MR7
C10
VT1
VT2
VT4
VT5
VT6
C4
R45
VT14
MR6
R7
C15
R3
R5
C3
R9
R44
R15
R16
R47
R8
VT16
14
SIGNAL INPUT
C7 NOT USE



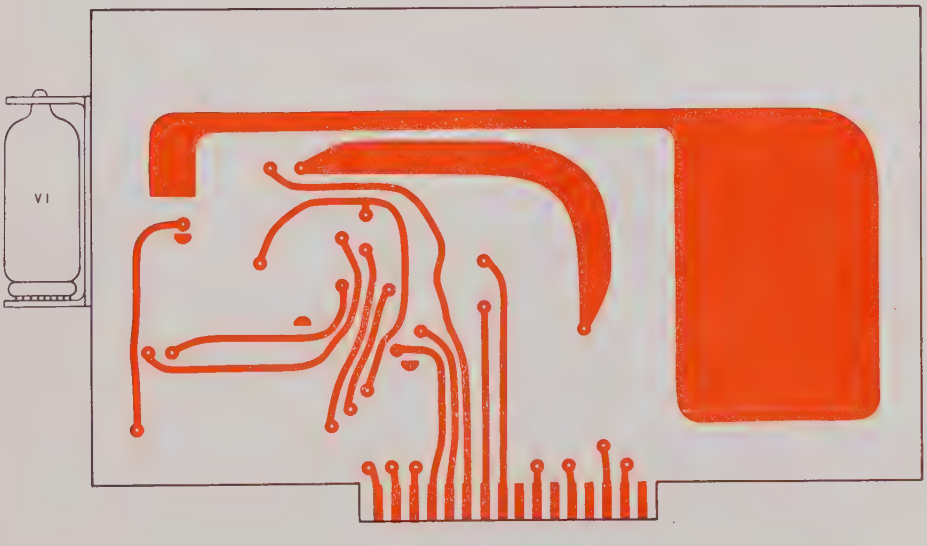
LAST R-47
" C-22
" VT-16
" MR-7

GATE CONTROL AND RESET

TYPE 66/602
DRG. NO ES66/77 ISSUE C



VIEWED FROM COPPER SIDE

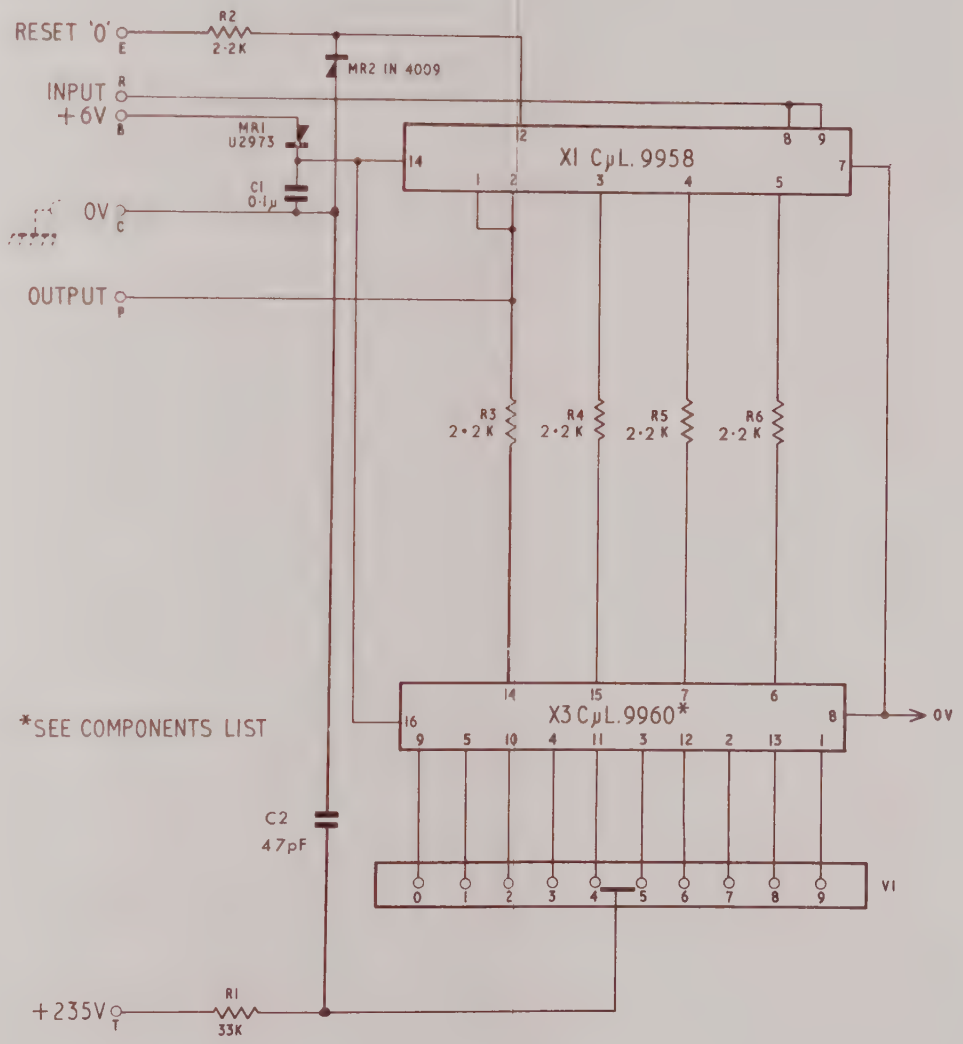


VIEWED FROM COMPONENT SIDE

REF: M2237B
M2238B

LOW SPEED COUNTER TYPE 66/710

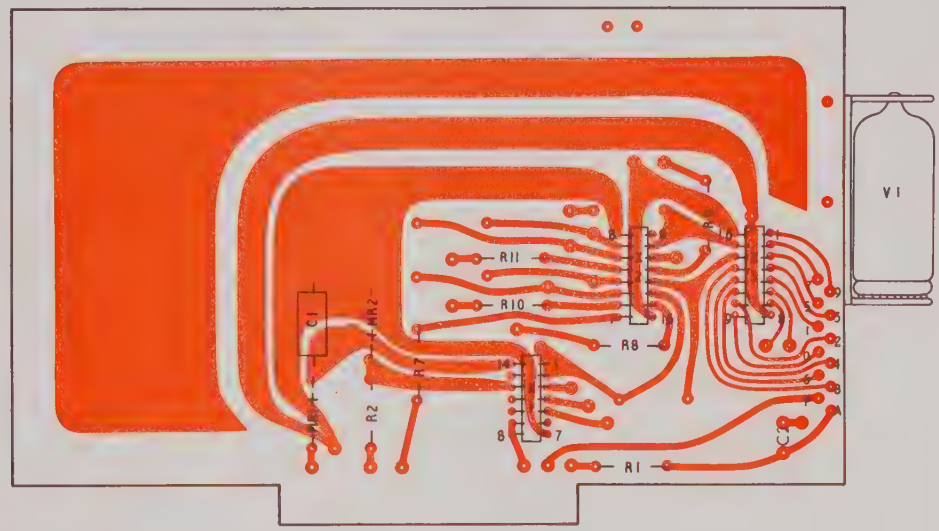
BL66/710



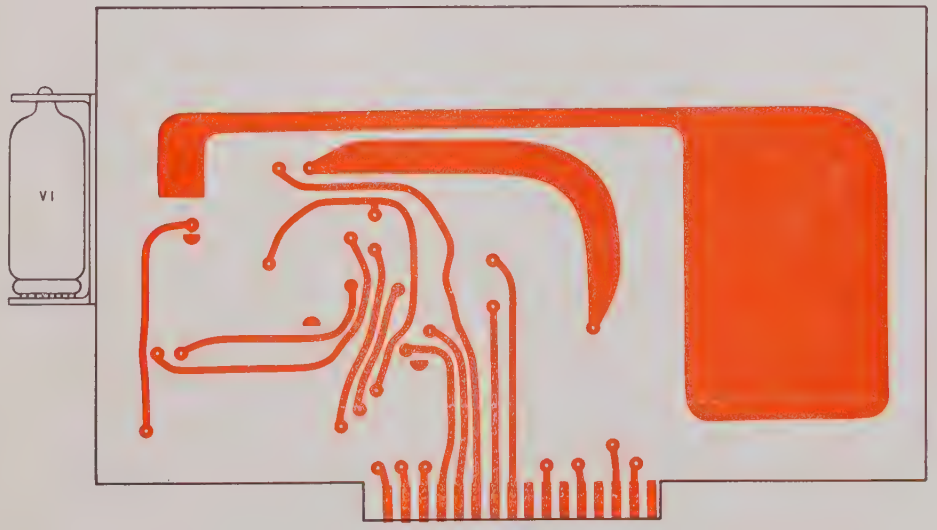
LOW SPEED INTEGRATED COUNTER

TYPE 66/710

DRG. NO ES66/91 ISSUE A



VIEWED FROM COPPER SIDE

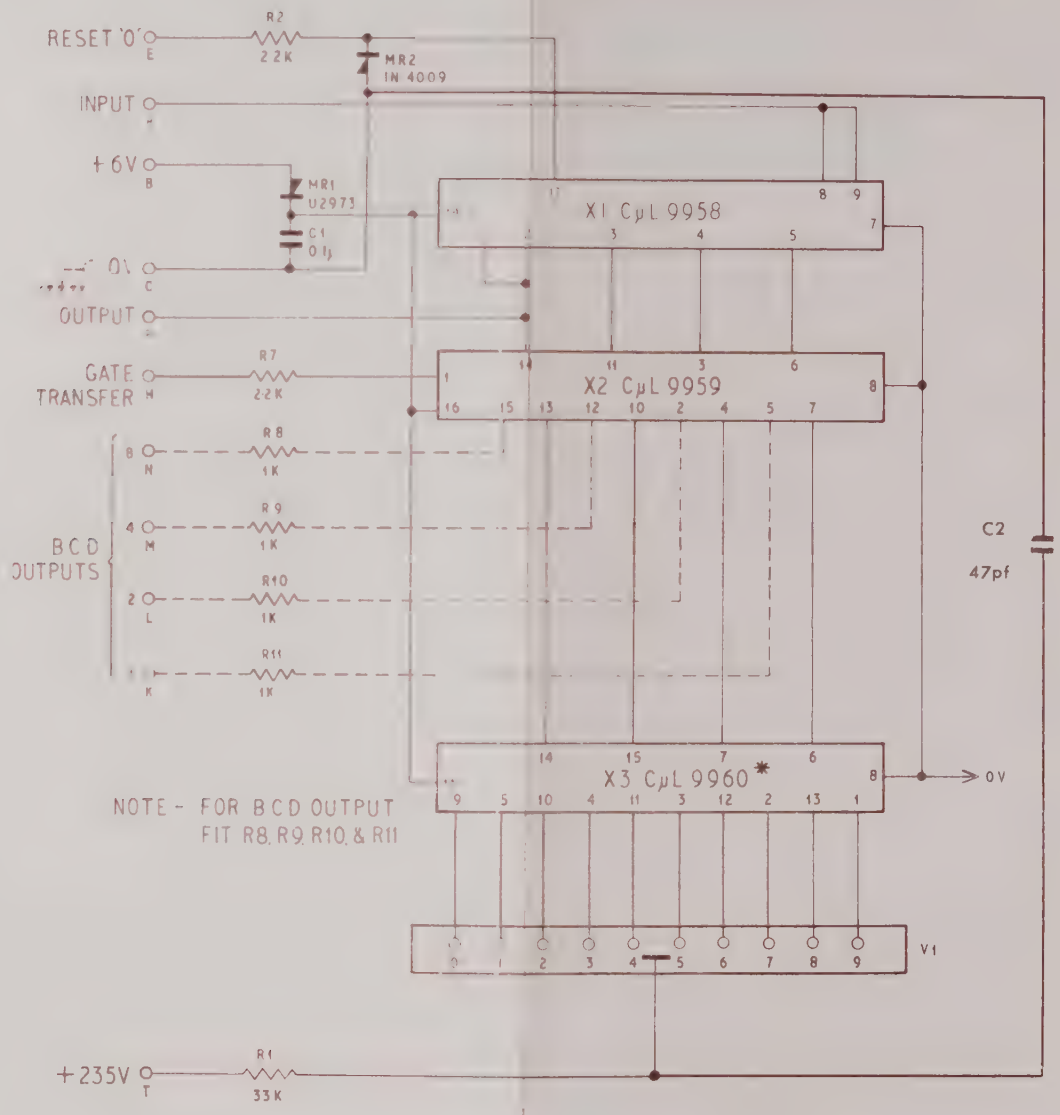


VIEWED FROM COMPONENT SIDE

REF: M2237B
M2238B

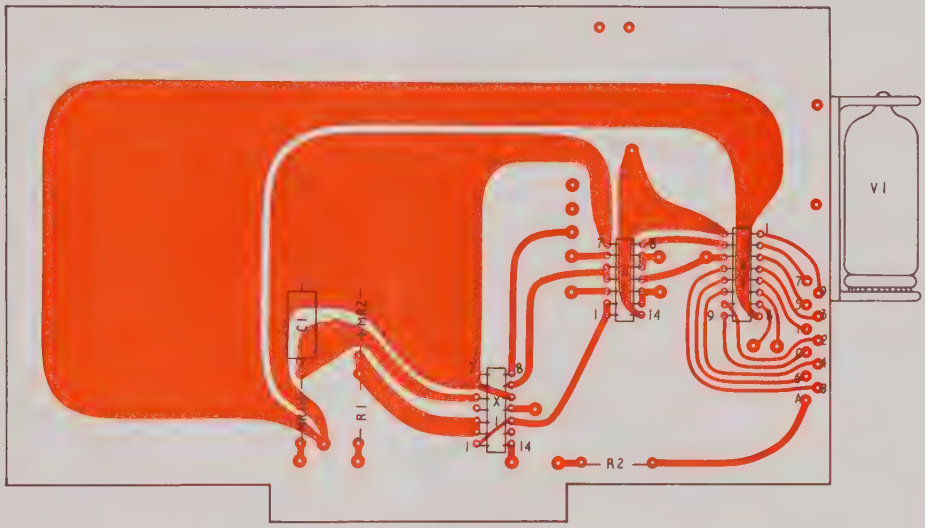
LOW SPEED COUNTER AND STORE TYPE 66/710M

BL66/710M

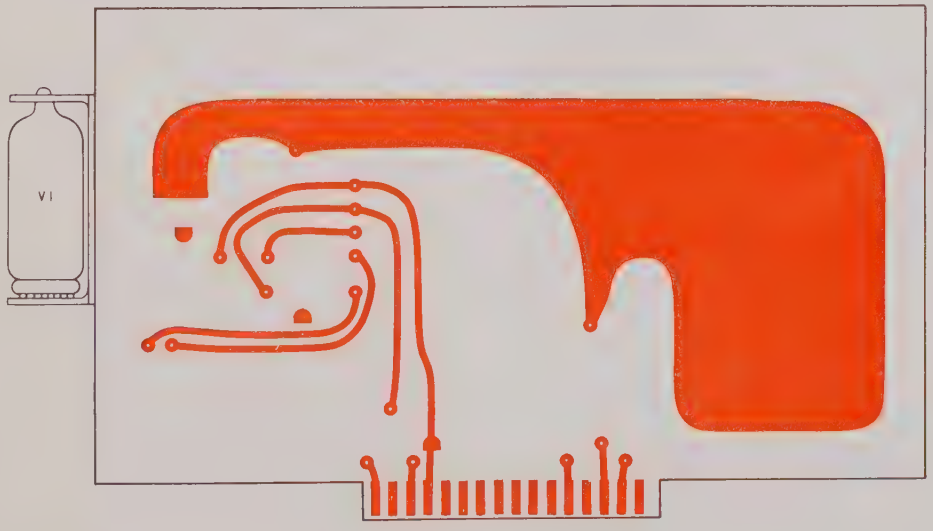


* SEE COMPONENTS LIST

LOW SPEED INTEGRATED COUNTER
WITH STORE
TYPE 66/710/M
DRG. NO. ES66/89 ISSUE A



VIEWED FROM COPPER SIDE

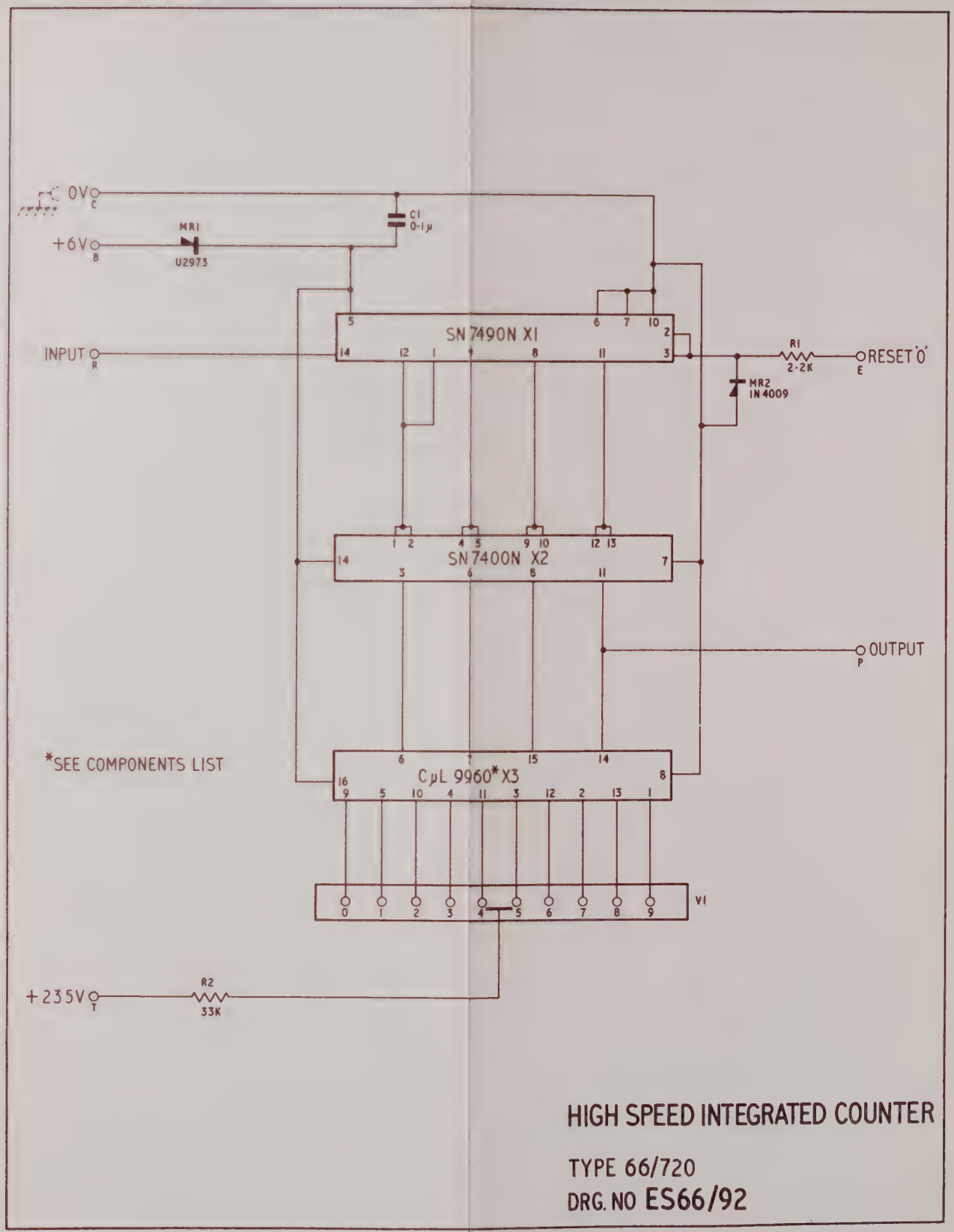


VIEWED FROM COMPONENT SIDE

REF: M 2234
M 2235

HIGH SPEED COUNTER TYPE 66/720

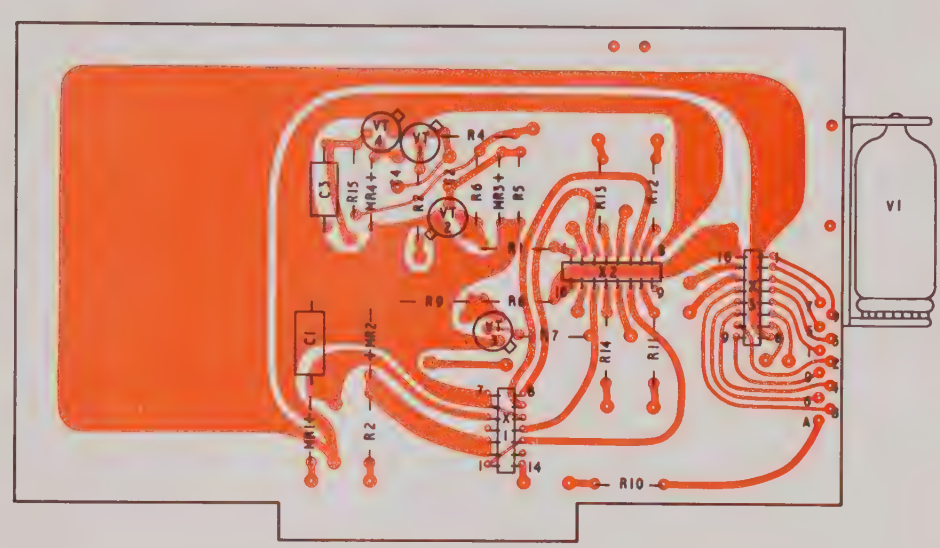
BL66/720



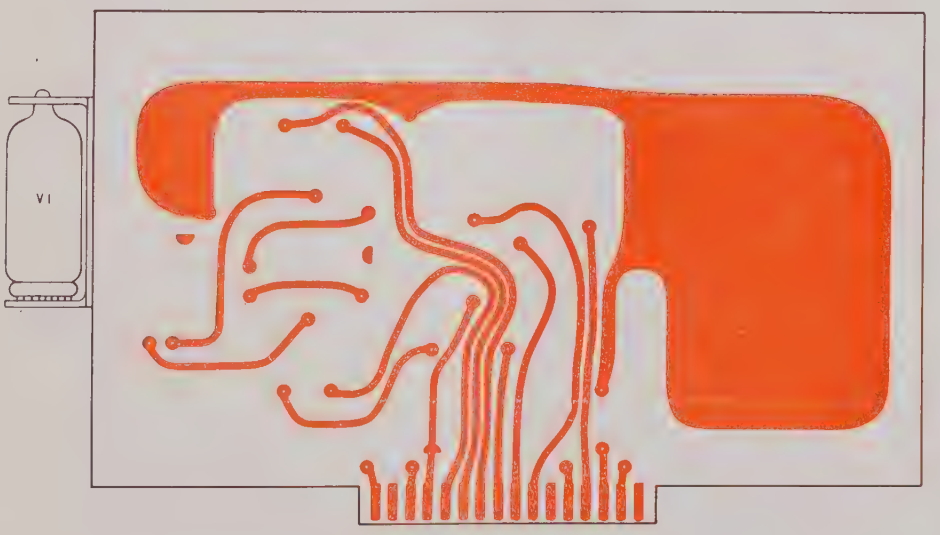
HIGH SPEED INTEGRATED COUNTER

TYPE 66/720

DRG. NO ES66/92



VIEWED FROM COPPER SIDE

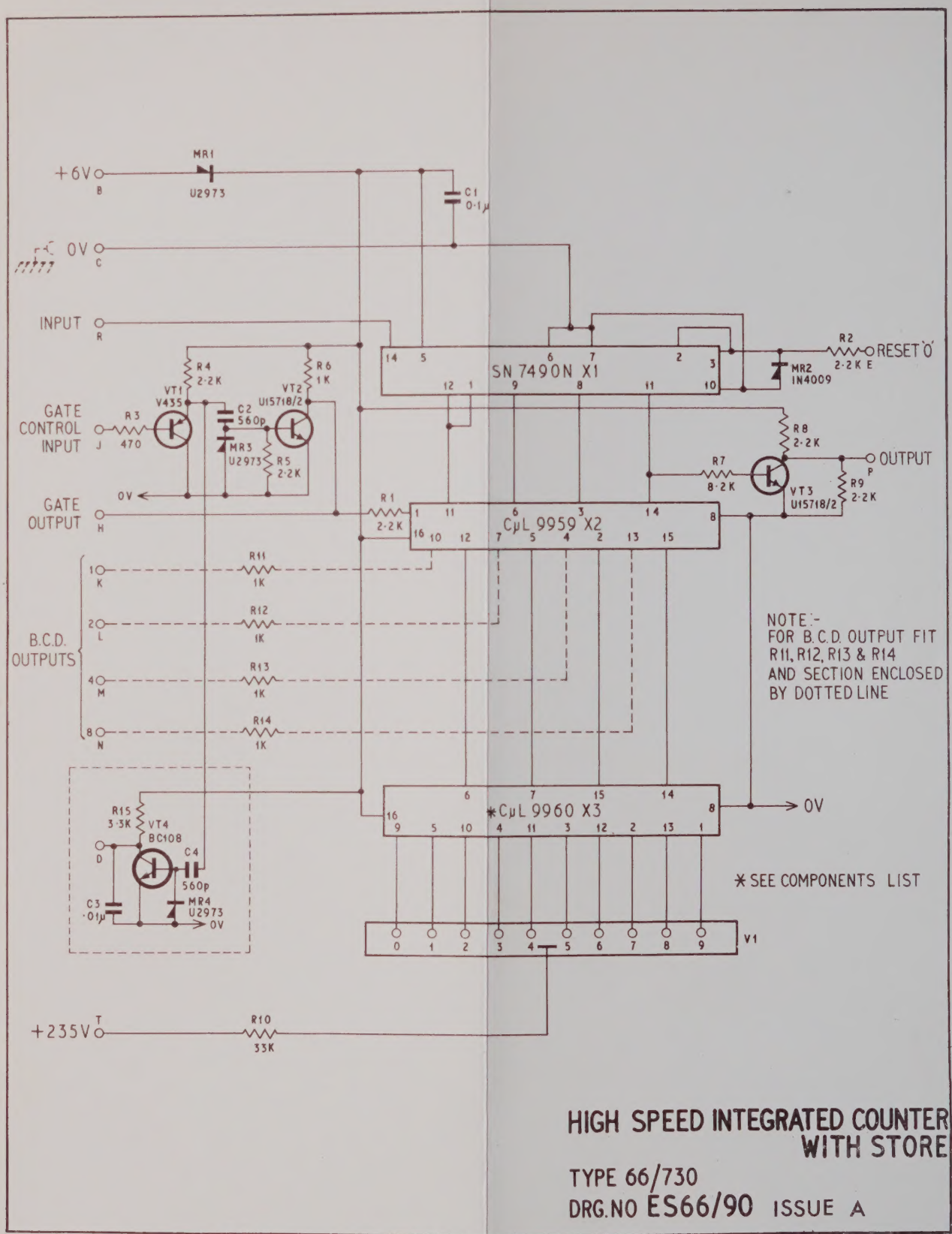


VIEWED FROM COMPONENT SIDE

REF: M2242A
M2241A

HIGH SPEED COUNTER AND STORE TYPE 66/730

BL66/730



HIGH SPEED INTEGRATED COUNTER WITH STORE

TYPE 66/730

DRG.NO ES66/90 ISSUE A

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